SCIENCE

Vol. 109 No. 2833 Friday, April 15, 1949

AAAS EDITORIAL BOARD

(Terms expire July 31, 1949)

Arthur C. Bevan Edward U. Condon

H. Bentley Glass

Malcolm H. Soule Everett S. Wallis

George A. Baitsell
Editor-in-Chief

Beth Wilson
Executive Editor of Science

F. A. Moulton, Advertising Representative

CONTENTS

A Color Translating Ultraviolet Microscope:
E. H. Land, E. R. Blout, D. S. Grey, et al. 371

Examination of the Target Theory by Deuteron Bombardment of T-1 Phage:
Ernest C. Pollard and *Frederick Forro, Jr.* 374

Technical Papers

Direct-reading Photocolorimetry:
John G. Reinhold 376

The Separation of Purine and Pyrimidine Bases and of Nucleotides by Ion Exchange:
Waldo E. Cohn 377

A Simplified Procedure for the Analytical Extraction of Lipids:
Joseph J. Kolb 378

Evidence that Amputation of Bacterial Flagella Does Not Affect Motility:
Adrianus Pijper 379

A Simple Technique for Continuous Registration of Blood Flow:
G. K. Moe 381

Inhibitor in Onion for Starch Synthesis:
H. C. Eyster 382

The Isthmic Mucous Membrane of the Human Uterus:
D. N. Danforth and *James C. F. Chapman* 383

Physical Studies on Corneal Tissues:
H. J. Adler, S. T. Gross and *J. M. Lambert* 383

Comments and Communications

Modified Ninhydrin Reagent in Quantitative Determination of Amino Acids by Paper Chromatography; More on High School Biology Requirements 385

News and Notes 387

Science, a weekly journal founded in 1880, is published each Friday by the American Association for the Advancement of Science at the Business Press, 10 McGovern Ave., Lancaster, Pa. Editorial and Advertising Offices, 1515 Massachusetts Ave., N.W., Washington 5, D. C. Telephone, Executive 6060. Cable address, SCIMAG, Washington, D. C. Entered as second-class matter at the Post Office at Lancaster, Pa., January 13, 1948, under the Act of March 3, 1879. Acceptance for mailing at the special rate postage provided for in the Act of February 28, 1925, embodied in Paragraph 4, Sec. 538, P.L. and R., authorized January 13, 1948.

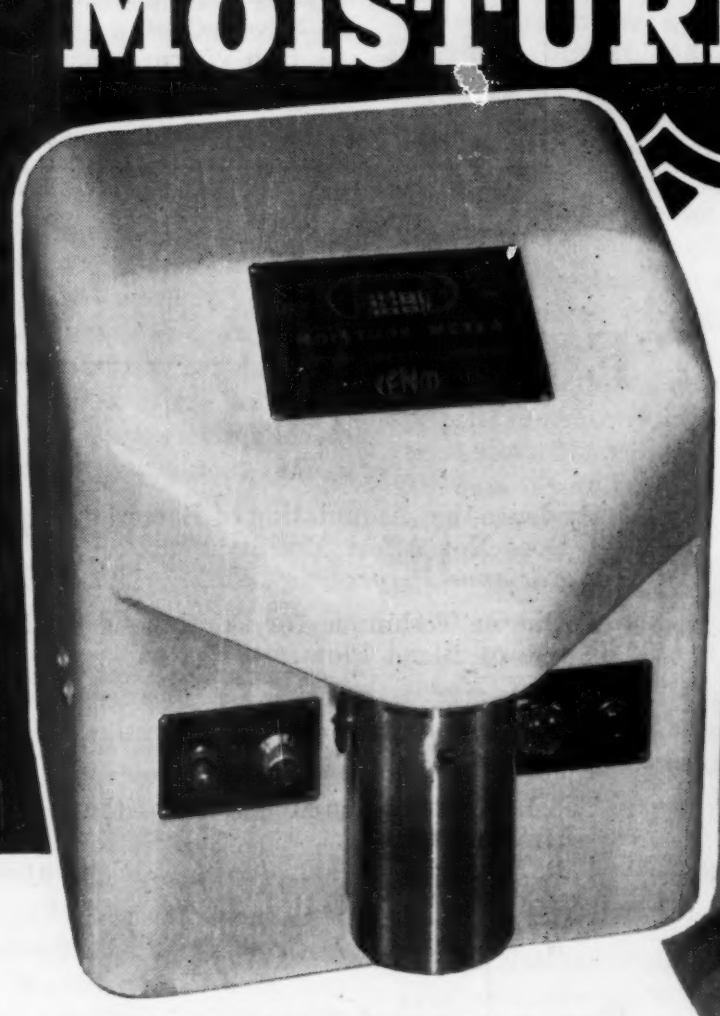
Manuscripts submitted for publication should be sent to the Editorial Office, with stamped, self-addressed envelope enclosed for possible return. The AAAS assumes no responsibility for the safety of the manuscripts or for the opinions expressed by contributors.

Annual subscription, $7.50; single copies, $.25; foreign postage, outside the Pan-American Union, $1.00; Canadian postage, $.50. Remittances and orders for subscriptions and single copies should be sent to the Circulation Department, *Science*, 1515 Massachusetts Ave., N.W., Washington 5, D. C. Membership correspondence for the AAAS should be addressed to the Administrative Secretary at the same address.

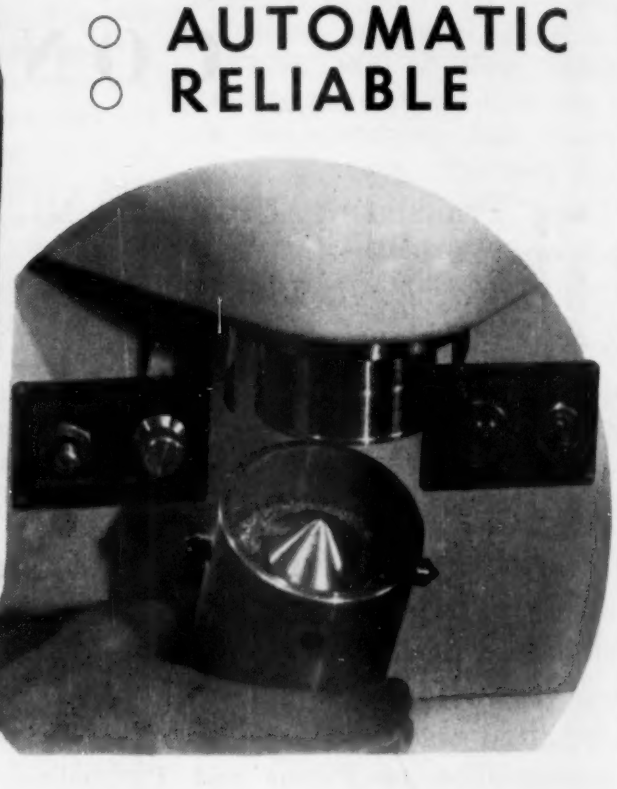
Change of address. Four weeks' notice is required for change of address. This should be sent to *Science* Recorder, 1515 Massachusetts Ave., N.W., Washington 5, D. C. When ordering a change, it is necessary to furnish an address stencil label from a recent issue. Claims for a missing number will not be allowed if received more than 60 days from date of issue. No claims allowed from subscribers due to failure to notify the Circulation Department of a change of address or because an issue is missing from their files, or for any reason from subscribers in Central Europe, Asia, or the Pacific Islands (other than Hawaii).

The AAAS also publishes *The Scientific Monthly*. Subscription rates on request.

ELECTRONIC MOISTURE METER



- RAPID
- AUTOMATIC
- RELIABLE



The Cenco-Patterson Electronic Moisture Meter was developed originally for the milling industry to enable rapid, accurate and automatic determinations of moisture in flour and wheat. It is direct reading, push-button operated from 115 volt lines, stable, self-contained and is being successfully applied to read the moisture content of flour, wheat, rye, coffee beans, popcorn, corn, oats, kaffir, barley and other similar materials. Potential applications are many, although at present confined to granular and powdered substances.

Moisture readings are accurate measurements of electrical capacitance. The range and accuracy of the instrument, where applicable, is sufficient to cover most industrial materials.

Write for descriptive information and prices. Ask for CNC63.

SERVING SCIENCE CENCO

CENTRAL SCIENTIFIC COMPANY

Scientific Apparatus · Instruments · Chemicals

1700 IRVING PARK ROAD, CHICAGO 13

NEW YORK BOSTON SAN FRANCISCO NEWARK LOS ANGELES TORONTO MONTREAL

A Color Translating Ultraviolet Microscope[1]

E. H. Land, E. R. Blout, D. S. Grey, M. S. Flower,
H. Husek, R. C. Jones, C. H. Matz, and D. P. Merrill

Research Laboratory, Polaroid Corporation, Cambridge, Massachusetts

THE DESIGN of monochromatic ultraviolet microscope objectives by Köhler and von Rohr (*13, 14*), their commercial production by Zeiss, and their use in conjunction with photographic film marked an important step forward in man's ability to see very small structures in spectral regions where his eyes are not sensitive. Many investigators (cf. *7, 8, 9, 16, 17, 21*) have used this ultraviolet microscope in the examination of plant and animal tissues. Ultraviolet microscopy of such substances has been useful because the inherent absorption of biological materials in the ultraviolet region makes possible photography without the use of dyes or stains, and because the shorter wavelengths of the incident radiation allow approximately twice the resolving power that can be obtained with visible light.

The well-known Zeiss ultraviolet microscope objectives, because they are monochromats, are restricted to use at one wavelength for a given focal setting. On the other hand, the microscope described here is not only achromatic, but also apochromatic from 220 to 800 mμ. This makes possible a new conception of the method of using an ultraviolet microscope; namely, to use simultaneously or sequentially three different ultraviolet wavelengths, and to convert the ultraviolet images so obtained into visible images in three primary additive colors. When these three images are superposed, a visible image in full color is obtained. This procedure was earlier suggested by Brumberg and others (*4, 5, 23*). The colored image which is seen might be thought of as what the eye would see in the microscope if its receptors had their peak sensitivities at the ultraviolet wavelengths in question.

We now wish to present a preliminary description of a system of ultraviolet microscopy and an instrument which employs this procedure. The system employs photography with rapid development and fixation to convert the ultraviolet image into a visible image. The procedure involves image formation with an apochromatic ultraviolet microscope objective (*11*), exposure of successive areas of the film using three different wavelength bands of ultraviolet light, rapid development and fixation of the three latent photographic images, and the simultaneous projection of the three fixed images through three additive color filters to give a full-color representation of the object in terms of its ultraviolet absorption. Although other means of wavelength translation such as fluorescent screens and television methods have been considered (*12*), it was decided on the basis of sensitivity, availability, and particularly retention of a permanent record, first to develop an instrument using photographic techniques.

The instrument (Fig. 1) employs a superhigh pressure, water-cooled mercury arc (Type A-H6) as a light source (A), a Wadsworth-type grating monochromator (B), a microscope (C) using apochromatic objective lenses and identical lenses as condensers, the camera (D) which employs 35-mm motion picture film, the film-processing station (E), the three-beam projector (F), and the viewing screen (G). The instrument will be described in detail in a subsequent publication, but it is perhaps worth while to mention at this time a few pertinent characteristics of the components now in use.

A.) The characteristics of the superhigh pressure mercury arc have been described (*1, 2, 10, 22*). This source was found to be the brightest of a great variety of sources examined in the region 260 to 400 mμ. Exposure times required vary from 0.01 to 30 seconds, depending not only on the wavelength region, the film type, and developing conditions, but also to a considerable extent on the age of the arc. The achievement of proper exposure will be facilitated by an automatic photoelectric exposure control device now under construction.

B.) The monochromator was designed and constructed in this laboratory and employs a Baird Associates 15,000 line per inch grating (B_1) approximately 3 by 1.5 inches in area. Settings for wavelength are made reproducible by means of micrometer-controlled stops. Band widths are controlled by slit size.

C.) The optical system of the microscope will be described in more detail in a subsequent communica-

[1] This work has been supported since its origination by the Office of Naval Research, and is now being sponsored jointly by that Office and the American Cancer Society.

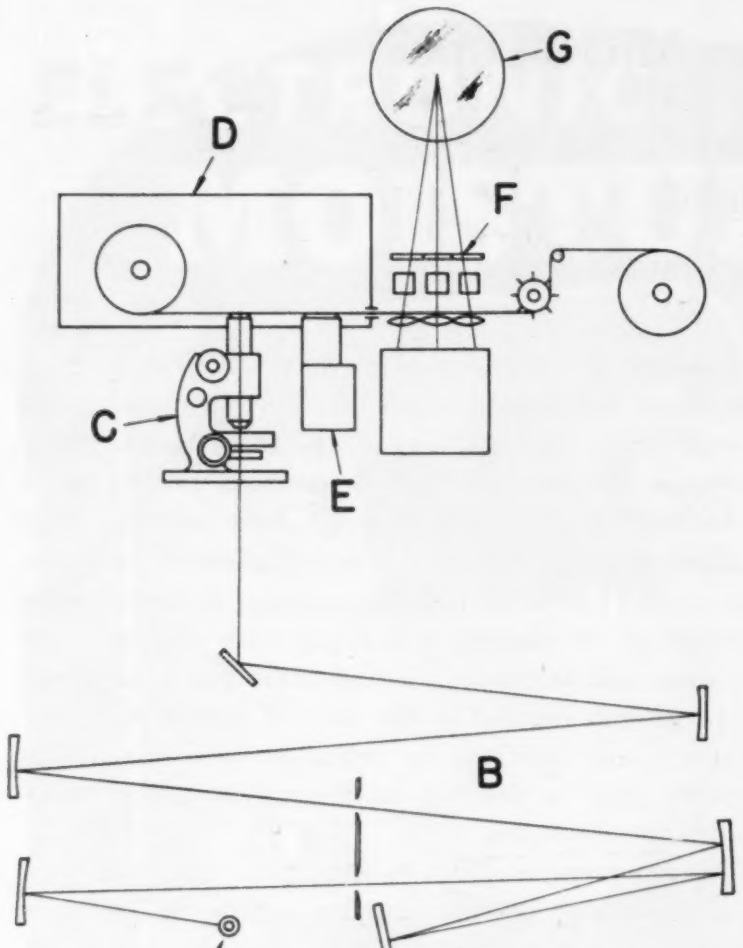


FIG. 1. Schematic diagram of color translating ultraviolet microscope: A—light source, B—monochromator, B_1—diffraction grating, C—microscope, D—camera, E—film processing station, F—three-beam projector, G—viewing screen.

tion (*11*). The objective and condenser are apochromatic over the wavelength range 220–800 mμ. This of course means that it is now possible to focus the microscope for ultraviolet light by focusing it with visible light; this eliminates what has previously been one of the most difficult aspects of ultraviolet photomicroscopy. Two objectives, one of a reflecting type (*6, 18*) and one of a combined reflecting-refracting type, having numerical apertures of 0.4 and 0.72 respectively, have been designed and constructed. These lenses fit into a standard microscope stand (Fig. 2) and may be used as condensers as well as objectives, although an achromatic quartz-fluorite ultraviolet condenser has also been made. The objectives may be used without eyepieces and provide magnifications of 77× and 200× before projection. Lenses of higher numerical aperture and with similar apochromatic properties are now being developed.

D.) The main requirement of the camera is that successive frames be indexed very accurately (to at least 0.001 inch), so that the subsequent triple projection is in register. Approximately 400 feet of 35-mm film can be used in one loading.

E.) After the film is exposed, it moves on automatically to the film processing station, where successive treatment of the emulsion with hot alkaline developer, hot fixer, water, and air produces within 10 seconds a stable negative suitable for projection (*3*). The useful diameter of the processing cup is 0.7 inch, and therefore this is also the diameter of the developed area. The principal mechanical-chemical problems of fast processing, such as time cycle, temperature control, and homogeneity of processing, have been solved.

F.) After the development and fixation of the negative image, the film is moved on to a projector, where three images which had been taken successively at three different ultraviolet bands are projected simultaneously through three additive color filters (red, green, blue) upon a 4½-inch circular translucent screen. The magnification from the film to the screen is eight times. The resulting single, full-color image is reasonably sharp and bright, and may be viewed by several persons simultaneously.

The relationship between the visible and ultraviolet bands may be chosen for maximum color contrast, since there are no "natural" colors. With three ultraviolet bands and three visible colors, there are six possible combinations of the images and filters. In addition there is the possibility of processing the ultraviolet image to yield a positive rather than a negative. We have examined the six negative and six positive color combinations, using ultraviolet photo-

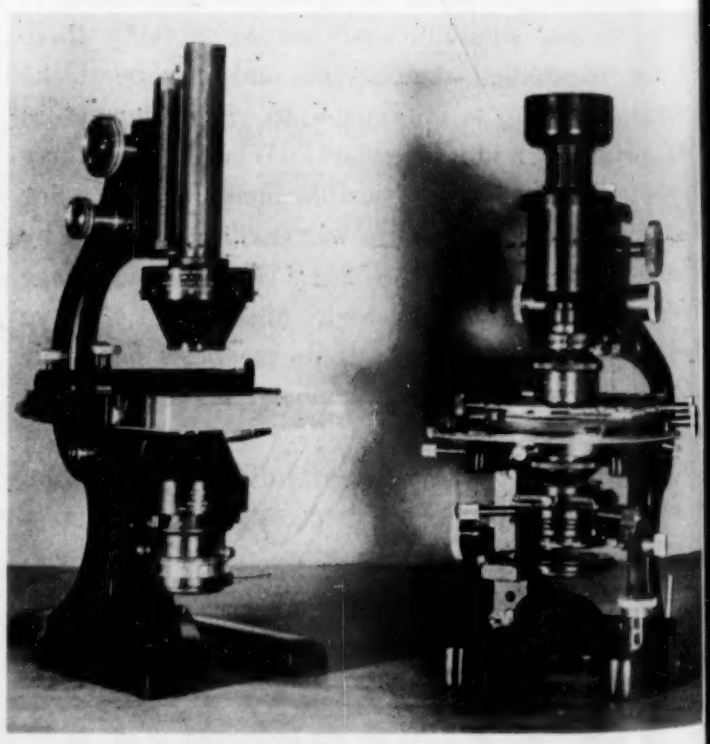


FIG. 2. Apochromatic reflecting-type microscope lenses in conventional stands: 0.4 NA objective lens (left); 0.72 NA objective lens (right); identical lenses used as condensers.

micrographs of tissue sections, and, on the basis of using equal gammas and equal background densities in the negatives, have selected the following as showing the greatest color contrasts:

Ultraviolet Wavelength	*Visible Wavelength*	
	Negative	*Positive*
Short (~ 265 mμ)	Green	Blue
Medium (~ 285 mμ)	Red	Green
Long (~ 315 mμ)	Blue	Red

We are not unmindful that with the use of other ultraviolet wavelengths or the use of other photographic procedures, different color combinations may show better color contrast.

In the mechanical arrangement employed in the instrument, the visible color filters are segments of a rotatable disc arranged so that as each new image is developed and moves into the projector, an image that had been projected through the same color filter moves out of the projector; and the two remaining images are advanced one frame, along with their respective filters. Thus the desired correspondence of ultraviolet and visible wavelengths is maintained once it is set.

G.) The clear screen brightness obtained through the three filters is about 100 foot-lamberts. Use is made of a special plastic-in-plastic screen (*15*) which gives the maximum screen brilliance, maximum evenness of illumination, and maximum definition of any of the many different types of translucent screens we have investigated. The addition of a plastic Fresnel condensing lens (*20*), placed directly back of and in contact with the screen, aids in achieving even illumination.

The device is called a color translating microscope, rather than a micrograph, because the manipulative operations involved and the general time requirements are rather similar to those involved in ordinary visual microscopy. One sits adjacent to the microscope, moves the slide about on the microscope stage, changes the focus as desired, and—without significant delay—studies the magnified, full-color image. The instrument is different from an ordinary microscope in that it permits several persons to view the image simultaneously, provides permanent records of what is seen, and of course permits observation of specimens in terms of their ultraviolet absorption.

In Fig. 3 we have reproduced three black-and-white ultraviolet photomicrographs of the type used for color projection. Unfortunately, since full-color printing is not used in this journal, we are unable to reproduce a color photomicrograph with this article.

Finally, it should be pointed out that the 35-mm black-and-white film, with its groups of three images, each corresponding to a different ultraviolet band, provides a permanent photographic record of each experiment, which can be examined at leisure, or each group of three images may be processed into a single full-color photograph. For example, a picture may be taken of the image on the projection screen with color film such as Kodachrome or Anscocolor, or the black-and-white negatives may be used as color-separation negatives in the Technicolor or Polacolor processes. This color film may then be viewed in an ordinary 35-mm motion picture or slide projector, thus

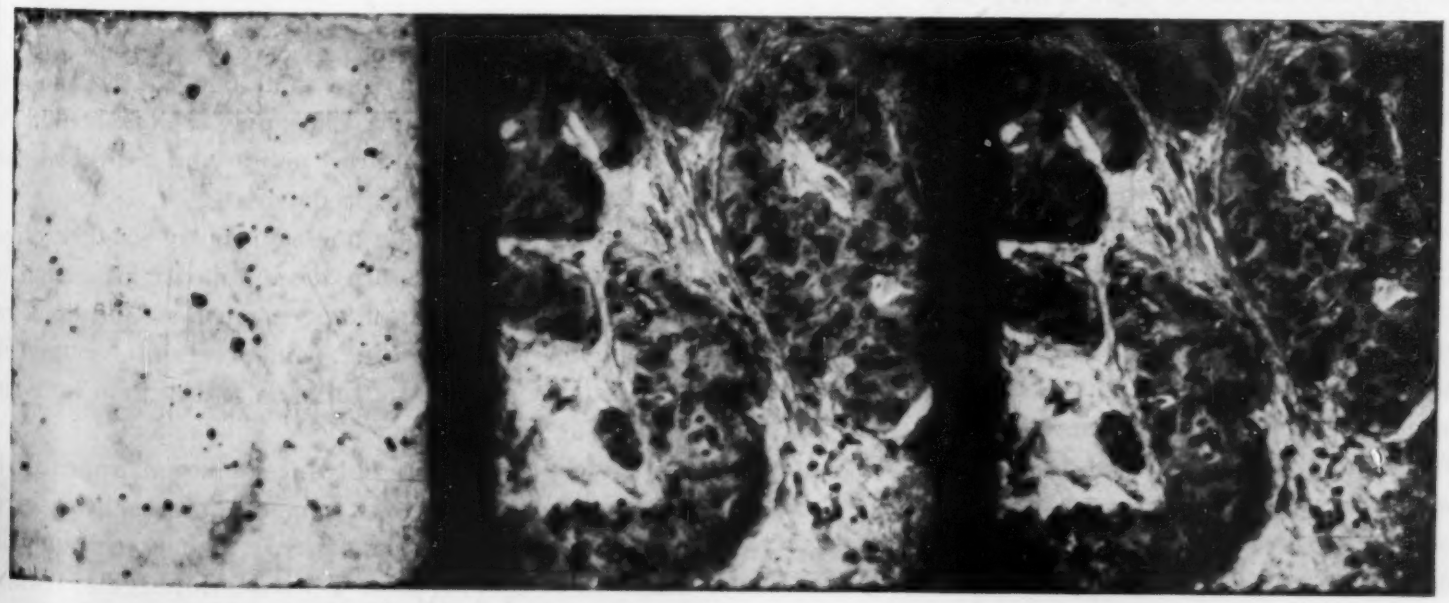


FIG. 3. Positive print from a 35-mm film strip showing three pictures taken at peak transmissions of 315 mμ (left), 285 mμ (center), and 265 mμ (right); band width approximately 10 mμ in each case; photographed with 0.4 NA apochromatic reflecting lenses used as objective and condenser; subject, unstained intestinal carcinoid showing argentaffine cells; specimen (furnished by Dr. Maurice L. Pechet, Children's Hospital, Boston, Massachusetts) prepared by formalin fixation, embedded in paraffin, cut at 4 μ thickness, and mounted in glycerin on Vycor slide.

making possible careful, prolonged study of subjects of ultraviolet color-translation photomicrographs.

We wish to acknowledge the invaluable technical assistance of the following members of our research staff: Messrs. A. G. Carpenter, M. Fairbank, M. Parrish, Jr., N. T. Pierce, and S. A. Stone, and also Dr. S. S. Ballard, Consultant in Physics to Polaroid Corporation. We are indebted to Dr. R. C. Mellors and Dr. C. P. Rhoads of the Sloan-Kettering Institute for Cancer Research for supplying us with many specimens of tissue used (19) *and for valuable advice and encouragement from the inception of this work. We also wish to acknowledge the excellent cooperation of Mr. L. V. Foster and the staff of Bausch and Lomb Optical Company in the construction of the microscope lenses, that of Dr. H. C. Yutzy and the staff of Eastman Kodak Company in supplying special photographic films, and the able assistance of Mr. Clifton Tuttle of Kenyon Instrument Company in the engineering of the developing unit and projector.*

References

1. Barnes, B. T., and Forsythe, W. E. *J. opt. Soc. Amer.*, 1937, **27**, 83.
2. Bol, C. *Das Licht*, 1935, **5**, 84; *Ingenieur*, 1935, **50**, 91.
3. Brown, F. M., Blackmer, L. L., and Kunz, C. J. *J. Franklin Inst.*, 1946, **242**, 203.
4. Brumberg, E. M. *Compt. rend. acad. sci. U.R.S.S.*, 1939, **25**, 473.
5. *Ibid.*, 1941, **32**, 486.
6. Burch, L. R. *Proc. phys. Soc., Lond.*, 1947, **59**, 41.
7. Caspersson, T. *Skand. Arch. Physiol.*, 1936, **73**, suppl. 8.
8. Caspersson, T. *J. Roy. Microscop. Soc.*, 1940, **60**, 8.
9. Cole, P. A., and Brackett, F. S. *Rev. sci. Instr.*, 1940, **11**, 419.
10. General Electric Co., Engineering Division, Lamp Dept. Bulletins LD-1 and LS-103.
11. Grey, D. S. Publication pending.
12. Jones, R. Clark. Publication pending.
13. Köhler, A. *Zeit. wiss. Mikroskopie*, 1904, **21**, 129, 273.
14. Köhler, A., and Rohr, M. v. *J. Roy. Microscop. Soc.*, 1905, **25**, 513.
15. Land, E. H. U. S. Patent No. 2,287,556, June 23, 1942.
16. Lavin, G. D., and Hoagland, C. L. *Proc. Soc. exp. Biol. Med.*, 1943, **52**, 80.
17. Lucas, F. F. *J. Franklin Inst.*, 1934, **217**, 661.
18. Maksutov, D. D. USSR. Patent No. 40859, Dec. 13, 1932.
19. Mellors, R. C. *Amer. J. Med.*, 1948, **5**, 626.
20. Miller, O. E., McLeod, J. H., and Sherwood, W. T. *J. opt. Soc. Amer.*, 1948, **38**, 1104.
21. Mirsky, A. E., and Pollister, A. W. *Biol. Symposia*, 1943, **10**, 247.
22. Noel, E. B. *J. appl. Phys.*, 1940, **11**, 325.
23. Shurcliff, W. A. U. S. Patent No. 2,369,317, Feb. 13, 1945.

Examination of the Target Theory by Deuteron Bombardment of T-1 Phage

Ernest C. Pollard and Frederick Forro, Jr.[1]
Biophysics Division, Yale University

THE BIOLOGICAL ACTION OF IONIZING RADIATIONS is of great current importance. The effects produced are often readily measured and a clear understanding of the process involved is therefore capable of yielding structural information about biological systems.

Lea (*2*) has examined carefully the target theory of biological action according to which a localized sensitive volume of definite size exists and within which there must be considerable liberation of energy for biological action to take place. This direct action is certainly not the only action and Lea has pointed out that indirect action by free radicals and by hydrogen peroxide will occur, particularly at low concentrations. According to his views a specimen irradiated in high concentration, and in the presence of a high concentration of large molecules, should have a low efficiency for indirect action and the direct, target type action should predominate.

There is today some question as to whether direct action ever occurs, since the similarity of action of mutagenic agents like nitrogen mustard and of X radiation is very striking, and certainly mutagenic agents must operate by collision rather than by penetration and ionization.

In view of this present uncertainty it appeared to us to be worth while to examine the target theory carefully in bombardments where it should certainly be valid. For this we chose T-1 bacteriophage (*1*) which acts on *E. coli*, strain B. This phage has a spherical head, diameter 50 mμ and a long tail, length 120 mμ of diameter 10 mμ. No complex genetic structure has been reported for this phage. We found it to be

[1] We wish to thank Mrs. Marjorie Reaume for very valuable help with the phage assays, Mr. F. Bisbee for help in constructing the bombarding equipment, and Drs. P. R. Burkholder and D. M. Bonner for much interest and helpful advice.

stable in broth, 0.4 grams percent. The stability was not affected by evacuation for several days. Our procedure was to bombard T-1 phage preparations in vacuo with a deuteron beam of known energy and to study the cross section of target resulting from such bombardment. By varying the energy of the deuteron beam the ionization density can be varied smoothly and accurately and a test of the target theory made.

Since the deuterons go in straight lines, distributed in a random manner in area, the target calculation assumes only that a deuteron passes through the target area. The chance of inactivation of N phage particles having a target area S each is then SN/A where A is the area of the whole preparation. The actual number of hits is given by $-dN$, and the chance is this number divided by the total beam, which is the preparation area times the number of deuterons per square centimeter or dB. This expression for the chance is $-dN/A\ dB$, and equating the two we have

$$\frac{SN}{A} = -\frac{dN}{A\,dB}$$

which leads to the relation $dN/N = -S\ dB$ or on integrating

$$\frac{N}{N_0} = e^{-SB} \qquad (1)$$

where N_0 is the number of phage particles present initially. When $N/N_0 = 37\%$, $SB = 1$ and in this way, by measuring B, S can be found.

The results are plotted as percent survival versus number of deuterons per cm² and show that relation 1 is obeyed. The results for three different beam energies are shown in Table 1.

TABLE 1

Beam energy (Mev)	Energy loss per cm air (Mev)	B for 37% survival ($\times 10^{11}$ deuterons)	Apparent radius mμ
3.5	0.18	1.2	16.5
2.5	0.25	1.04	17.5
1.5	0.40	0.83	19.5

The value of the apparent radius, assuming the target to be a spherical volume, is given, together with the value of B for 37% survival and the energy loss of the beam per centimeter air equivalent.

The number of ion pairs introduced into a target of this volume is in each case in excess of 8 so that on the simple hypothesis of Lea that one ion pair liberated in the target produces inactivation, the target should appear to have the same area. The fact that it does not requires some modification of the theory.

In order to have some basis for this modification, we studied the temperature inactivation (in broth) of the same phage. The results are given in Table 2.

TABLE 2

Temperature (absolute)	K (sec^{-1})
343	2.78×10^{-3}
338	7.94×10^{-4}
336	1.93×10^{-4}
333	5.03×10^{-5}

These show that there is an activation energy for the inactivation process of 73.6 kcal per mole or 3.2 ev. This, of course, includes a large amount of entropy change. Nevertheless, if it is assumed that the absorption of 3.2 ev of energy in a target of diameter about 30 mμ will cause inactivation it is possible to estimate the distance from which radiation can reach the target to produce inactivation. This distance increases with ionization density and accounts for the apparent increase in the target area.

It is therefore proposed that Lea's hypothesis be modified by including the possibility that inactivation can be caused by secondary radiation reaching the target from an ion path which does not go through the target. An approximate quantitative treatment can be given as follows. Suppose I ev/cm² are released by the deuteron. Let the path of the deuteron approach within a distance y of a target of radius R. Then it can be assumed that approximately the intensity at the surface of the target is aI/y, where a is some slowly varying quantity dependent on the proportion of energy emitted as ultraviolet light suitable for inactivation and on absorption in the medium. If the absorption coefficient of the target is μ then the energy absorbed is approximately $\frac{2\pi\mu aIR^3}{y}$ so that the condition for inactivation is

$$\frac{2\pi\mu aIR^3}{y} = 3.2.$$

This can be rewritten as $y = \left[\frac{2\pi\mu aR^3}{3.2}\right] I.$

This equation cannot be interpreted literally since the requirement that 3.2 ev be sufficient is clearly only a hypothesis and also the approximations regarding absorption are rather rough.

However, the ideas it expresses can be put to good use. If one regards the term in brackets as constant, and it is essentially so, one can write

$$y + R = \text{constant} \cdot I + R$$

Now $y + R$ is the radius of the apparent target volume as calculated above. When $y + R$ is plotted against I

(Continued on page 386.)

TECHNICAL PAPERS

Direct-reading Photocolorimetry

John G. Reinhold[1]

The Pepper Laboratory of Clinical Medicine, Hospital of the University of Pennsylvania, Philadelphia

The use of photocolorimeters is becoming increasingly widespread and in many laboratories has completely supplanted the visual colorimeter. When large numbers of analyses are made, the calculation of results may become a time-consuming chore. It is possible to simplify such calculations by an expedient whereby the scale readings are made to express directly the quantities of the unknown substance analyzed. When applied to the analysis of blood sugar, the result in mg per 100 ml can be read directly from the scale of the Klett-Summerson photocolorimeter. The method is applicable also to other types of photocolorimeters.

The relationship between the density of the color in the solutions derived from the standard and unknown samples and their respective concentrations is illustrated in the equation

$$C_u = (R_u - R_b)\frac{C_s}{(R_s - R_b)}$$

in which C_u and C_s are the concentration of material analyzed in unknown and standard samples; R_u, R_s, and R_b are the readings in terms of optical density of unknown, standard, and blank samples.

If R_b reads zero or if the instrument is adjusted so that $R_b = 0$ then the foregoing expression becomes

$$C_u = R_u \frac{C_s}{R_s}$$

It will be seen that if $R_s = C_s$, then $C_u = R_u$ and no calculation is necessary. This relationship seldom is encountered; however, it can be established or closely approximated by selection of a filter or wavelength setting that will have the effect of expanding or contracting the light absorption for each unit of substance to make it divisible evenly into the units of the scale. An adjustment of shutter or galvanometer setting then can make R_s equal to C_s or to some simple multiple of C_s, nC_s. Then

$$C_u = (R_u - R_b + d)\frac{C_s}{(R_s - R_b + d)}$$

where d represents the effect of the shutter adjustment. If the relationship between light absorption of the solution and filter is such that the change from $R_b = 0$ to $R_s = nC_s$ is small then d will be small and for values of C_u near C_s, R_u will be approximately equal to C_u. The error at $C_u = 0$ is given by the deviation of R_b from zero.

To illustrate, the following procedure was used in adapting the Somogyi-Nelson blood sugar method to this system of measurement by means of a Klett-Summerson photocolorimeter. Three standard solutions containing glucose equivalent to blood sugar concentrations of 50, 100, and 200 mg per 100 ml respectively, and a blank tube containing reagents only were prepared together with the unknowns. A filter having maximum transmission at 540 mμ was tested first. With the cuvette containing the blank in position and the dial scale set at zero the shutter was adjusted to give a null reading on the galvanometer. Next the three standards were read and scale readings of 65, 120, and 245 were obtained. Since these values were not conveniently convertible to the corresponding blood sugar values, a filter having maximum transmission at 500 mμ was tested. The adjustment of the blank to zero was repeated, and the three standards now read 54, 103, and 205. These readings approximated the desired range and this filter consequently was selected. For measurement of blood sugar in the normal range, the cuvette containing the 100 mg standard was placed in the instrument. The dial was set to 100 and the galvanometer restored to the null point by means of the shutter adjustment. Readings of the unknowns were then taken directly from the dial. They agreed (within the limits of error of the readings) with the blood sugar values for the same specimens calculated by a conventional procedure.

When the method is applied to photocolorimeters scaled to read transmissions, a setting is selected that will give a simple fraction when converted to optical density. To illustrate, the method used in this laboratory for determination of cholesterol employs the Evelyn photocolorimeter. Two standards containing 0.4 mg and 0.8 mg of cholesterol together with the unknown samples are treated with acetic anhydride and sulfuric acid. With the reagents currently in use, and when conditions for development of color are kept uniform, galvanometer readings of the 0.8 mg standard closely and consistently approximate 32. With the colored solution derived from the 0.8 mg. standard in place, the galvanometer is set at 31[a]. The optical density (L value) corresponding to this is 0.498. Dividing it into 0.8 gives a quotient of 1.6. While this quotient is not a whole number, selection of a serum sample of the proper size, in this instance 0.16 ml, simplified the final calculation. The result, expressed as mg of cholesterol in 100 ml of blood, is obtained by multiplying the L value by 1000. Similarly, the second standard, if needed, is set at 56[1] giving an L value of 0.250. Since the color developed is not entirely stable, each

[1] The technical assistance of Misses Jane Bourne and Rhoda Greenberg is acknowledged with thanks. The paper includes several helpful suggestions made by Dr. J. Harold Austin.

standard is replaced in the instrument at regular intervals and the setting readjusted to maintain the standards at the desired L values. Marked change in readings or lack of consistency in the color developed by the standards would preclude use of the simplified method, although the same objection would apply to results obtained by conventional procedures.

The accuracy obtained will depend on the extent to which the readings of the standards deviate from the desired scale values and the consequent extent of the shutter or galvanometer adjustment. It has been possible to select filters or alter sample sizes so that this deviation was kept to less than 5 mg per 100 ml for blood sugar, 1 mg per 100 ml for blood urea N, and 0.1 g per 100 ml for serum protein in a range of values ordinarily encountered. If the instrument adjustment required is appreciable, error will increase in proportion (1) as zero is approached, and (2) as the difference between concentration of the unknown and that of the standard increases.

Application of this method of calculation does not necessarily require that standards be included with each run. In clinical laboratory procedure, however, this is desirable regardless of the system of calculation employed, particularly when equilibrium reactions like those involved in blood sugar determinations are utilized.

The method described deviates partially from the accepted principles of photometry and any new applications should be thoroughly tested. Furthermore, it deliberately introduces an approximation and thus should be used with discrimination. However, it is suitable for many purposes and has proven to be of great convenience where large numbers of analyses are required in a minimal period as in the clinical laboratory. Here it has expedited analyses and decreased the number of errors arising in calculation of results.

The simplified procedure has been applied to determinations of blood sugar, urea nitrogen, serum total protein, and free and esterified cholesterol. The results in each instance have agreed closely with those obtained by the standard method of readings. Differences have been small and without statistical significance.

The Separation of Purine and Pyrimidine Bases and of Nucleotides by Ion Exchange

Waldo E. Cohn

Biology Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee

As a prelude to tracer studies on the enzymatic formation and degradation of nucleic acids, we have undertaken to develop ion exchange techniques for the separation and analysis of the various bases, nucleosides, and nucleotides at the milligram level. Although this technique is finding increasing application in biochemical studies for separation of these compounds (*8, 9*) and others (*1, 2, 6, 7*), we were led independently to its use

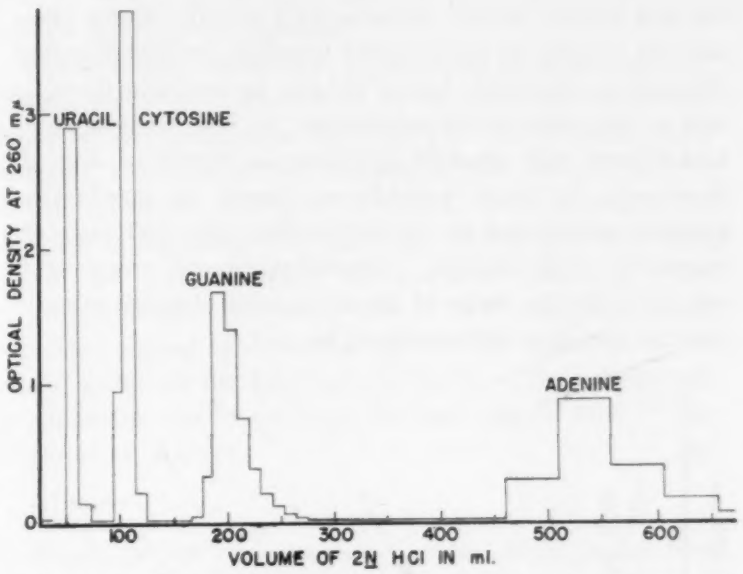


FIG. 1. Separation of purine and pyrimidine bases by cation exchange. *Exchanger*: 8.1 cm × 0.74 cm² Dowex-50, ca. 300 mesh, H^+ form. *Eluting solution*: 2*N*-HCl at 0.6 ml/min. *Test material*: 0.5 mg uracil, 1.0 mg each of adenine, guanine, and cytosine, in 7.5 ml 2*N*-HCl. *Recoveries*: 98.5–101.5% (based on optical density at 260 mμ).

through our earlier experience with radioisotope separation by ion exchange chromatography (*4, 11*). The present note describes briefly methods we have developed for the separation of each of the purine and pyrimidine bases and of the ribose nucleotides.

Of the five naturally occurring purine and pyrimidine bases, three (cytosine, guanine and adenine) exist as cations in solution of pH < 4 and hence are able to combine with cation exchangers. Since their affinities for the cation exchanger differ, they may be eluted successively with such simple reagents as HCl or NaCl; this is demonstrated in Fig. 1. This procedure does not separate

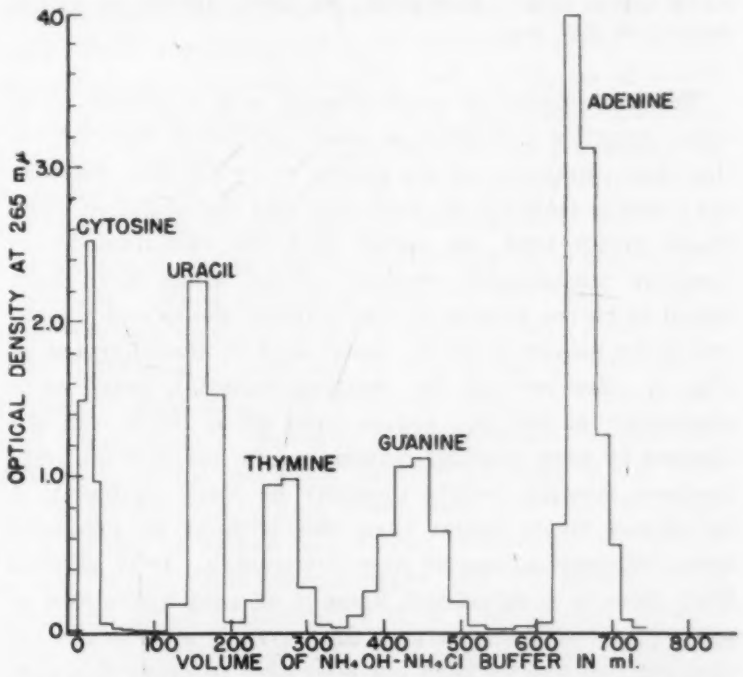


FIG. 2. Separation of purine and pyrimidine bases by anion exchange. *Exchanger*: 8.5 cm × 0.74 cm² Dowex-Al, ca. 300 mesh, Cl^- form. *Eluting solution*: 0.2*M*-NH_4OH-NH_4Cl buffer, pH 10.6, 0.025 *M*-Cl^- (at 575 ml, pH changed to 10.0, Cl^- to 0.1 *M*), at 0.25 ml/min. *Test material*: 1 mg cytosine, 2 mg each of other bases, in 10 ml eluting solution. *Recoveries*: 97.5–99% (based on optical density at 265 mμ).

the non-ionized bases, thymine and uracil. Since these will not usually be encountered together, no disadvantage attaches to this fact, but it is easy to separate them, as well as the other three substances, by resorting to anion exchangers[1] and alkaline solutions as shown in Fig. 2.[2] Recoveries by both procedures, based on spectrophotometric absorption in the ultraviolet (260–265 mμ) are essentially quantitative. Identification of components was made by the shape of the ultraviolet absorption curve and by partition chromatography (*3*).[3]

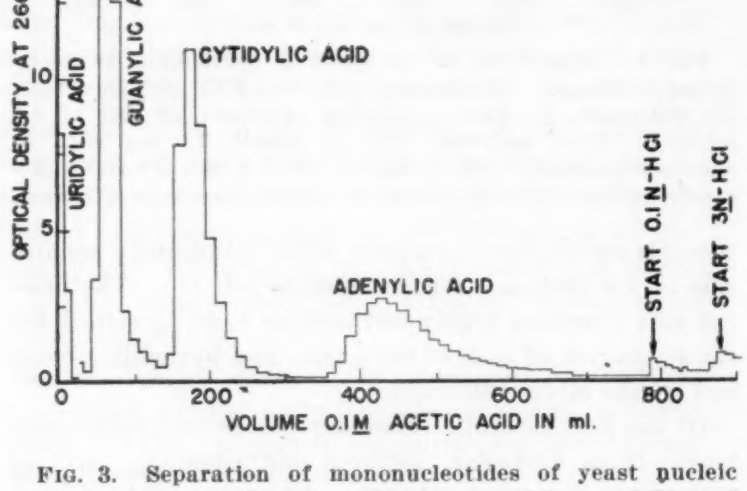


FIG. 3. Separation of mononucleotides of yeast nucleic acid by cation exchange. *Exchanger*: 24 cm × 0.74 cm² Dowex-50, ca. 300 mesh, H^+ form. *Eluting agent*: 0.1 *M* acetic acid at 0.15 ml/min. *Test material*: 100 mg mixed nucleotides, recovered from their Ba salts following 0.6*N*-$Ba(OH)_2$ hydrolysis of yeast nucleic acid (conversion of nucleic acid to nomonucleotides not quantitative), in 10 ml 0.1 *M* acetic acid. *Recoveries*: 85–100% (based on optical density at 260 mμ).

The nucleotides of yeast nucleic acid (uridylic, cytidylic, guanylic and adenylic acid) exhibit to some degree the basic properties of the purine or pyrimidine constituent; this is modified by both size and the negative phosphate group with the result that the exchanger-to-ion bond is considerably weaker. Weak acids have been found to be the most practical eluting agents and a separation by means of dilute acetic acid is demonstrated in Fig. 3. Recovery of the starting material, based upon absorption at 260 mμ, varies from 85 to 100%. In the absence of pure starting materials (the commercial preparations showing 5–50% impurity by these methods), it is difficult to do better than this without an extensive series of preparations of pure compounds. It is possible that there is a significant amount of acid hydrolysis of purine nucleotides occurring during their stay in the exchanger bed but we have not been able to prove this conclusively. Regardless of this possibility, the method as it stands will isolate the bulk of each constituent in spectrophotometrically pure form.

Concentration and metathesis of the large volumes collected in the separations are easily achieved (*5, 10*), where evaporation is undesirable, by recycling the effluent through the same column, washing with water to remove residual acid or base, and then eluting with a reagent which removes the adsorbed ion rapidly (e.g., NH_4OH in the acid separations).

Although the separations reported are all at or near the milligram level, we have been able to effect practical separations on the same size columns on up to nearly 100-mg amounts. The lower limit is, of course, set by the limit of detection. At the higher levels, overlapping of bands becomes more prominent because of the relationship between the concentration of an ion and its distribution coefficient (*12*).

The details of these and related separations, with examples of their application to specific problems, will be reported elsewhere.

[1] The Dowex-A1 anion exchanger, a strong base, was kindly furnished us by Dr. L. Matheson of the Dow Chemical Company, Midland, Michigan.

[2] These experiments were carried out by Mr. J. X. Khym.

[3] We are indebted to Dr. C. E. Carter not only for the chromatographic analyses but also for continued encouragement and assistance during the course of these experiments.

References

1. ARCHIBALD, R. M. *J. biol. Chem.*, 1944, **156**, 121.
2. CANNAN, R. K. *J. biol. Chem.*, 1944, **152**, 401.
3. CARTER, C. E. (Unpublished data).
4. COHN, W. E., and KOHN, H. W. *J. Amer. chem. Soc.*, 1948, **70**, 1986.
5. COHN, W. E., PARKER, G. W., and TOMPKINS, E. R. *Nucleonics*, 1948, **3**, 22.
6. CONSDEN, R., GORDON, A. H., and MARTIN, A. J. P. *Biochem. J.*, 1948, **42**, 443.
7. DRAKE, B. *Nature, Lond.*, 1947, **160**, 602.
8. ELMORE, D. T. *Nature, Lond.*, 1948, **161**, 931.
9. HARRIS, R. J. C., and THOMAS, J. F. *Nature, Lond.*, 1948, **161**, 931.
10. KOCHOLATY, W., and JUNOWICZ-KOCHOLATY, R. *Arch. Biochem.*, 1947, **15**, 55.
11. TOMPKINS, E. R., KHYM, J. X., and COHN, W. E. *J. Amer. chem. Soc.*, 1947, **69**, 2769.
12. TOMPKINS, E. R., and MAYER, S. W. *J. Amer. chem. Soc.*, 1948, **69**, 2859.

A Simplified Procedure for the Analytical Extraction of Lipids[1]

Joseph J. Kolb

Lankenau Hospital Research Institute and
The Institute for Cancer Research, Philadelphia

Recently Hsiao (*3*) described a procedure for the extraction of lipids from fish tissues. When this procedure was applied to pulverized, moist, mouse muscle tissues certain difficulties were encountered. The tissues clumped, adhered to the walls of the extraction tube, and did not disperse during the extraction period, thus interfering with complete extraction.

In order to circumvent these difficulties, to expedite the extraction of comparatively large numbers of samples, and at the same time to attain the fine state of division recommended by Bloor (*1*) the following procedure was developed.

The method of preparation of the tissue for extraction is that of Floyd (*2*) and Singher (*6*). A glass

[1] Aided by a grant in memory of Mary Frances Sarkisian.

mortar with pestle is placed in an evaporating dish, and surrounded by and filled with solid carbon dioxide; after thorough cooling of the mortar and pestle, the dry ice is removed from the mortar. The excised tissue, which has been stored in vials over dry ice, is thawed just enough so as to be transferable to the mortar, and dry ice equal to about three times the volume of the tissue is then added. When the tissue is again frozen solid, the mixture is ground until a fine homogeneous powder is obtained. Small bits of dry ice are, if necessary, added during the grinding. The ground powder is then transferred to a vial and the carbon dioxide allowed to evaporate until a pasty mass is obtained. As soon as this change has taken place the tissue is again frozen solid.

Samples of approximately 200 mg of the partially thawed ground tissue are weighed into 50 ml conical centrifuge tubes equipped with a 24/12 ⅋ outer joint.[2] The tube is hung on a balance by an easily made support (*4*). Five ml of 95% ethanol is added and the tube is stoppered and allowed to stand until the entire series of samples have been weighed (usually 6 or 12 samples). The samples are then thoroughly dispersed with the aid of a stirring rod, and sufficient alcohol is added to each tube to wash down the walls and the stirring rod so that a total of 10 ml of solvent is used for each 200 mg of moist sample.

Pyrex #2480 Allihn condensers (200-mm jacket, 19/38 ⅋ joints) are connected to the centrifuge tubes by special adapters. These adapters are provided with an inner 24/12 ⅋ joint and an outer 19/38 ⅋ joint.[3]

The heat source is an electric digestion furnace as described by Miller and Miller (*5*). Rate of boiling may be controlled by using either a variable transformer or by adjusting the height of each tube above the heating element. When the 10-min boiling period is completed, the extraction unit is raised from the heater. After cooling to room temperature, contents of the tubes are swirled to wash down solids that creep up the walls during extraction. After centrifuging 10 min at 3,000 rpm, the clear supernatants are decanted into tared aluminum weighing dishes (Fisher Scientific Co. #8-732). The dishes with contents are placed in a desiccator over calcium chloride under moderate vacuum. The extraction is repeated with an additional 10 ml of ethanol and the resulting supernatants are added to the dishes.

In order to insure complete dryness, the residues are placed on the following day into another desiccator over fresh calcium chloride under high vacuum.

If dispersion during boiling is thorough, the second extraction does not yield more than about 3% of the weight of residue resulting from the first extraction.

Eighteen samples in duplicate of normal and cancer tissue of mice were extracted, with an average difference of 2% between the results of pairs. The average sample weight used was 224 mg, and the evaporation residues ranged from 9.5 to 14.9 mg.

The following additional information may be obtained from a series of extractions. If the insoluble residue is dried in the centrifuge tube at 100° C overnight and weighed, the sum of the weights of the soluble and insoluble portions will give a value which agrees with that of independent drying experiments on the whole tissue ($100 \pm 3\%$). When this insoluble residue is ashed overnight in the centrifuge tube at 450°, and the resulting ash weighed, a correction for soluble ash can be obtained provided the total ash is known. The soluble ash in our series was $58 \pm 5\%$ of the total ash or 14% of the evaporation residue.

[2] These versatile centrifuge tubes may be obtained by special order from either Ace Glass, Vineland, New Jersey, or Corning Glass Works, Corning, New York.

[3] Made by J. F. Uhrig, 4104 North Fifth Street, Philadelphia 40, Pennsylvania.

References

1. Bloor, W. R. *Biochemistry of the fatty acids,* New York: Reinhold, 1943, p. 45.
2. Floyd, N. F. Personal communication.
3. Hsiao, S. C. *Science,* 1948, **107**, 24.
4. Kolb, J. J. *Chemist Analyst,* 1949, **38**, 15.
5. Miller, G. L., and Miller, E. E. *Anal. Chem.,* 1948, **20**, 481.
6. Singher, H. O. *Thesis on muscle protein,* Cambridge: Harvard University Press, 1942, p. 28.

Evidence that Amputation of Bacterial Flagella Does Not Affect Motility

Adrianus Pijper

Institute for Pathology, University of Pretoria, Pretoria, South Africa

In previous papers (*5*, *6*, *8*, *10*, *11*, *12*) the somewhat revolutionary theory was proposed that the motile bacteria which are commonly credited with flagella do not move by means of such flagella, but by means of undulating gyrating contortions of their spiral-shaped bodies. Bacterial flagella would then have to be regarded, not as motor organs, but as mucous twirls peeled off from the mucous capsule, through the very movement of the bodies.

Acceptance of this theory would have far-reaching consequences. When applied to bacteria, the word "flagellum" (which means "whip") would have to be invested with quite a new meaning, or else be given up and replaced by something like "mucous twirl." "Bacillus" and "bacterium" (meaning "rod") would become misnomers in many instances, because although a rod need not be straight, an object which definitely has the shape of a spiral, or rather coil, cannot reasonably be termed a rod. Apart from nomenclature, the new theory would obviously affect classification in a fundamental manner. This might, however, at the same time lead the way to a phylogenetic classification. Teachers might like the new theory, for with less emphasis on the appearance and importance of "flagella," irksome "flagella staining" might be given up!

Notwithstanding my several publications on the subject, and the production of a cinemicrographic film in

which the new ideas are worked out step by step,[1] the new theory has received scant attention. Stuart Mudd (*4*) merely stated that it was not so. With the exception of the new edition of Zinsser's *Textbook of bacteriology* (*14*), which gave it "honorable mention" in the form of a very adequate description, bacteriologists seem reluctant to make up their minds. Conn and Elrod (*2*) have published some criticisms, mostly based on electron photomicrography with its unavoidable artifacts, but they left most of my arguments unanswered, and in their final summing up the question was still not settled. Van Iterson (*16*) based her criticism mostly on electron micrographs of the large spirilla, like *Spirillum volutans*, and I have just been able to show (*13*) that in this particular group of microbes the supposed flagella are of an unusual kind and have nothing in common with those of what are usually termed motile bacteria. The new edition of Bergey's Manual (*1*) and the new textbook of Frobisher (*3*) avoid all reference to my divergent views. Tanner and Tanner (*15*) in the new edition of their textbook mention the possibility of "a contractile membrane, or a snake-like movement" in motile bacteria, but at the same time they copy a drawing which shows *Salmonella typhosa* surrounded by more than a hundred flagella. This is of course in keeping with the old belief that motile bacteria "lead a double life," one inside the cell wall and another one outside it, unless one subscribes to the still stranger assumption that a cell wall may be pierced by flagella in more than a hundred places.

In this note I bring a further argument, based on a recent experiment, in support of the new theory.

By using my *sunlight* dark ground technique (*7*, *9*) I have shown that *Salmonella typhosa* (chosen because it is a typical representative of motile bacteria) when grown in suitable broth, exhibits a long thin tail when it is moving fast (Fig. 1). This tail can be seen on occasion to untwist itself into a number of wavy threads which arrange themselves in irregular fashion around the bacterial body and then after a while float away or disappear. All this is illustrated in the motion picture mentioned before. Their appearance and arrangement correspond to the traditional pictures of stained peritrichous flagella and the supposed flagella of electron micrographs. Obviously then, the tails of Fig. 1 are twisted bundles of what are commonly called bacterial flagella, and if these "flagella" were motor organs then the tail would be a motor organ.

On a previous occasion (*10*) I have shown that *Salmonella typhosa*, when grown in unsuitable broth or in simple peptone water, does not *show* tails and yet is perfectly motile. From this it would seem to follow that motility is not dependent on the presence of the tail, or in other words, that *Salmonella typhosa* can propel itself without outside motor organs. As a counterargument one might say that in such unsuitable culture media

[1] This motion picture is available from Prof. Harry E. Morton, Chairman of the Committee on Materials for Visual Instruction in Microbiology, Society of American Bacteriologists, University of Pennsylvania, School of Medicine, Philadelphia 4, Pennsylvania.

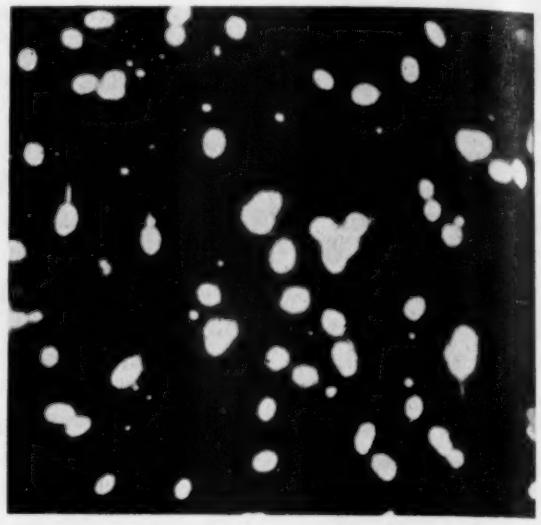


FIG. 1

the tail might have become too thin to be visible. I have therefore this time gone a step further and taken a culture of *Salmonella typhosa* in suitable broth, wherein nearly every individual was very motile and showed a good tail in the sunlight dark ground microscope, and then I have literally taken off the tails. This can be done by subjecting a portion of the culture to vigorous shaking for 15 minutes. The apparatus used was a Griffin & Tatlock Microid Flask Shaker, and it really vibrates more than it shakes. After this treatment the culture was again examined under the microscope; practically all the tails had disappeared but motility was as good as before the treatment, and as good as in the untreated portion, which still showed excellent tails. The bacteria in both portions exhibited their curious gyrating, undulating movement, which shows that during active life they are spiral-shaped, and evidently this movement is quite adequate to propel them. The whole experiment was repeated six times on different cultures, always with the same result.

The fact that one can, as it were, amputate the so-called flagella from motile bacteria and not interfere with their motility shows conclusively that such "flagella" are not motor organs.

References

1. BERGEY'S *Manual of determinative bacteriology*. (6th ed.) Baltimore: Williams & Wilkins, 1948.
2. CONN, H. J., and ELROD, R. P. *J. Bact.*, 1947, **54**, 681.
3. FROBISHER, M. *Fundamentals of bacteriology*. Philadelphia: W. B. Saunders, 1947.
4. MUDD, S. *Nature, Lond.*, 1948, **161**, 200.
5. PIJPER, A. *J. Path. Bact.*, 1938, **47**, 1.
6. ———. *J. biol. Photog. Ass.*, 1940, **8**, 158.
7. ———. *J. Path. Bact.*, 1946, **58**, 325.
8. ———. *J. Bact.*, 1947, **53**, 257.
9. ———. *J. biol. Photog. Ass.*, 1947, **16**, 3.
10. ———. *A motion picture of bacterial shape and motility*. Pretoria: Wallachs', 1947.
11. ———. *Photog. J.*, 1948, **88B**, 2.
12. ———. *Nature, Lond.*, 1948, **161**, 200.
13. ———. *Flagella of Spirillum volutans*, in press.
14. SMITH, D. T., and MARTIN, D. S. *Zinsser's textbook of bacteriology*. New York: Appleton-Century, 1948.
15. TANNER, F. W., and TANNER, F. W., JR. *Bacteriology* (4th ed.) New York: Wiley, 1948.
16. VAN ITERSON, W. *Biochem. Biophys. Acta.*, 1947, 1, 527.

A Simple Technique for Continuous Registration of Blood Flow[1]

G. K. Moe

Department of Pharmacology of the University of Michigan, Ann Arbor

Methods used in research laboratories for recording blood flow such as thermoelectric flow meters, the rotameter, and the photographically recording differential manometer, are either too complex or too delicate for use in student laboratories. The bubble flow meter, while simple, has the disadvantage of giving point determinations rather than a continuous record. For purposes of demonstration or student laboratory experiments we have adapted a technique described by Fleisch (*1*), to permit registration on smoked paper. Although no original principle is involved, the following description is offered in the belief that others may find the instrument useful.

As first described, a closed U-tube containing dyed chloroform was used for recording the pressure drop across a stainless steel cannula (*2*). Kymographic records were obtained by following the water-chloroform meniscus manually by means of a pointer attached with thread to a recording stylus. In its present form, a membrane differential manometer is arranged to inscribe directly on the drum.

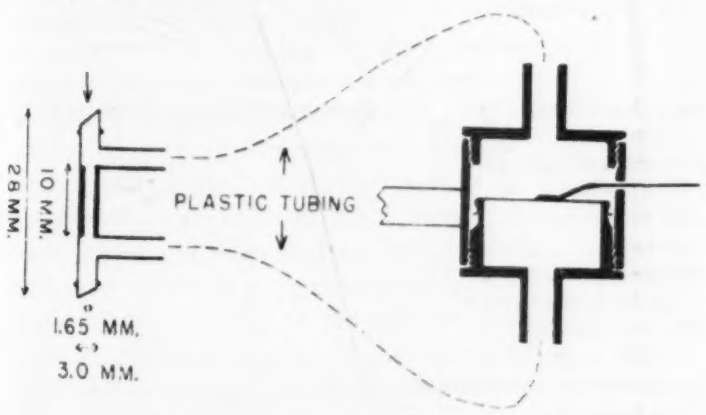


FIG. 1. Cannula and manometer drawn to same scale. Internal diameter of cannula at constriction, 1.65 mm.

The cannula is made of stainless steel; the inner surface is polished and coated with a silicone preparation. The dimensions given in the diagram (Fig. 1) are suitable for recording femoral arterial flow in dogs of 12 to 18 kg. The ends of the cannula are tied centrally and peripherally into the femoral artery; since blood is not diverted from the animal no warming device is required. The side tubes are connected through transparent plastic tubing to the brass manometer capsule. A short segment of rubber tubing attached to the distal side tube of the cannula permits introduction of a fine hypodermic needle directly into the blood stream.

The manometer capsule consists of a central cylinder threaded to receive the two end pieces, one serving as a tambour and the other as a cap. The tambour piece, fitted with dental dam tied in place with very little tension, is screwed into the cylinder. Stopcock grease applied to the threads ensures a water-tight seal. A short piece of wire is inserted through the fulcrum hole in the side of the cylinder, and the flattened end is cemented to the center of the rubber membrane with an aqueous-base latex suspension. The fulcrum is sealed off from the inside with several coats of the same cement, care being taken to obtain a water-tight joint, while allowing adequate flexibility for the movement of the lever arm. The cap is then screwed into place, and the instrument is filled with saline solution. A light pointer about 20 cm long is attached to the projecting end of the wire lever arm. In use, the capsule should be mounted cap down so that the weight of the lever presses the inner end up against the membrane.

[1] Development of this apparatus was begun when the author was at Harvard Medical School and was completed at the University of Michigan.

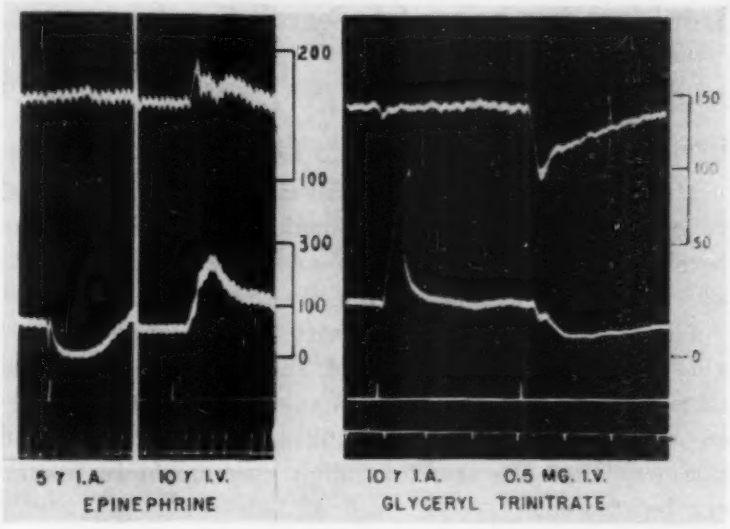


FIG. 2. Records of arterial pressure (above) and femoral arterial flow (below); two experiments. Epinephrine (left) and glyceryl trinitrate (right) were injected intra-arterially and intravenously. The upper scale represents pressure in mm Hg; the lower, blood flow in cc/min. Time signal: left tracing, 10 sec; right tracing, 1 min.

The cannula itself needs to be calibrated only once. This is done by passing blood at body temperature through the instrument and recording the pressure differential at various rates of flow by means of a closed U-tube containing chloroform under water. It should be recalled that 1 cm difference in height between the two chloroform menisci is equivalent to approximately 0.5 cm of water. The manometer capsule can then be calibrated when desired by applying a measured pressure differential to the two outlets. In our experience, at low flows the calibration curve approximates that predicted from the Poiseuille equation. At higher flows the pressure difference exceeds that predicted by the equation.

Heparinization of the animal is of course necessary. We have used a priming dose of 2 to 3 mg/kg, followed by continuous infusion of about 2 mg/kg/hr.

Records of arterial flow and pressure obtained in class demonstrations are illustrated in Fig. 2.

References

1. FLEISCH, A. *Arch f. d. ges. Physiol.*, 1920, **178**, 31.
2. MOE, G. K., BASSETT, D. L., and KRAYER, O. *J. Pharm. exp. Therap.*, 1944, **80**, 272.

Inhibitor in Onion for Starch Synthesis

H. C. Eyster

Charles F. Kettering Foundation, Antioch College

Most plants store starch in the chloroplasts of the leaf following photosynthesis. The main exceptions are members of the lily, iris, amaryllis, and gentian families (*1*, *2*). Onion is a member of the lily family.

Leaves are also able to absorb some sugars such as glucose, fructose, maltose, and sucrose, and transform them into starch. Leaf squares of etiolated corn floating on sugar solutions form an abundance of starch. It is in this way that the starch-forming mechanism in plants can be studied.

Juice from bulbs of cultivated onion as well as from leaves of wild onion (garlic) prevented the formation of starch in leaf squares of corn. The juice was extracted by means of a Carver laboratory press and added to a 1 M glucose or sucrose solution in equal amounts making the final concentration of juice 1: 2 and the sugar solution one-half molar. The control was set up by mixing the juice with an equal volume of water. The total amount of solution used was 15 ml in Petri dishes which had a total capacity of about 30 ml. At the end of 24 hr, leaf squares were tested for the presence of starch by first boiling them for a minute in water, second, extracting the yellow pigments in 95% ethanol, and finally applying a dilute solution of iodine (I_2KI) to the leaf squares spread out on a glass plate. The presence of starch in the control was indicated by a dark coloration.

Plants related to onion such as the day lily (lily family), jonquil and daffodil (amaryllis family), and American columbo (gentian family) also have the inhibitor (Table 1). Wild onion (garlic) leaves have a somewhat more potent concentration of the starch-forming inhibitor than the bulbs of the cultivated onion. Iris didn't seem to have much inhibitor. The test was made in midsummer and the result on iris may have been due to the time of year when the plant juice was tested. Day lily juice tested in summer had much less inhibitor than in spring, so there is a seasonal variation.

Juice from plants such as dandelion, wild carrot, wild strawberry, corn, and tomato which do store starch did not inhibit the formation of starch in the leaf squares of etiolated corn (Table 2). Juice from alsike clover and red clover did have a slight inhibitory effect in dilutions of 1: 2. While alsike clover and red clover do store starch, the slight inhibitory effect of the juice on starch formation in leaf squares of etiolated corn is as yet unexplainable.

Dilution of the juice from cultivated onion bulbs showed inhibitory influence during the first day up to dilutions of 40 to 80 times. Most or all of the effectiveness of the inhibitor seemed to be lost during the second day in cases where the juice was diluted more than 10 times.

The inhibitor of starch synthesis is not entirely heat stable nor is it entirely decomposed by heating to the boiling point momentarily and then cooling.

Day lily leaves do not form starch in the leaves under natural conditions. If leaf squares of the day lily are floated on .5 M glucose in the dark at room temperature, starch begins to form at the cut edges at the end of the second day. This is in accordance with Böhm who showed that some plants in which no starch is formed, e.g., *Galanthus, Hyacinthus, Ornithogalum,* and *Iris,* can be induced to starch formation when the leaves are kept on

TABLE 1

FORMATION OF STARCH IN LEAF SQUARES OF ETIOLATED CORN FLOATING ON .5 M GLUCOSE SOLUTIONS WHICH CONTAINED JUICES OF PLANTS NOT NORMALLY STORING STARCH

Plant	Starch test	
	Juice diluted 1 : 2	Juice diluted 1 : 15
No juice added (control)	Strong positive	Strong positive
Hemerocallis fulva (day lily)	Negative	Trace
Narcissus Jonquilla (jonquil)	"	Negative
N. Pseudo-Narcissus (daffodil)	"	Slight trace
Allium Cepa bulbs (onion)	"	Small positive
A. canadense (wild garlic)	"	Trace
Frasera carolinensis (American columbo)	Trace	.....
Iris versicolor (iris)	Small positive	Strong positive

TABLE 2

FORMATION OF STARCH IN LEAF SQUARES OF ETIOLATED CORN FLOATING ON .5 M GLUCOSE SOLUTIONS WHICH CONTAINED JUICES OF PLANTS NORMALLY STORING STARCH

Plant	Starch test	
	Juice diluted 1 : 2	Juice diluted 1 : 15
No juice added (control)	Strong positive	Strong positive
Taraxacum officinale (dandelion)	" "	" "
Zea Mays (corn)	" "	" "
Fragaria virginiana (wild strawberry)	" "	" "
Daucus Carota (wild carrot)	" "	" "
Lycopersicon esculentum (tomato)	" "	" "
Trifolium hybridum (alsike clover)	Small positive	" "
T. pratense (red clover)	Small positive	" "

a 20% solution of sucrose for 8–10 days (*2*). These plants have the mechanism for starch formation but do not form it under natural conditions, apparently because of the presence of an inhibitor.

Members of the lily, iris, amaryllis, and gentian families do not store starch in the leaves following photosynthesis, apparently because of the presence of a starch synthesis inhibitor. Onion, a member of the lily family, has the inhibitor.

References

1. Meyer, B. S., and Anderson, D. B. *Plant Physiology.* New York: Van Nostrand, 1938. P. 324.
2. Spoehr, H. A. *Photosynthesis.* New York: Chemical Catalogue, 1926. Pp. 184–185.

The Isthmic Mucous Membrane of the Human Uterus

D. N. Danforth and James C. F. Chapman

Departments of Obstetrics and Gynecology, and Pathology, Evanston Hospital, Evanston, and Northwestern University Medical School, Chicago

The purpose of this report is to present preliminary findings in a study of the mucous membrane lining the isthmic segment of the human uterus. These findings indicate that the isthmic mucosa is not peculiar, as it has been extensively described, but that, rather, it is an integral part of the corporeal andometrium.

According to current understanding, the isthmic mucosa is an entity in itself, separate and distinct from that of the cervix and corpus. A similarity with the endometrium is recognized, however, with the following exceptions: the isthmic mucosa is described as being thinner, poorer in glands, and richer in supporting tissue. Also, its glands are said to react poorly to the ovarian hormones, and to contain no glycogen during the secretory phase. A further difference is the reported absence of coiled arterioles, which are a prominent feature of the endometrium. The conclusion from these observations is that although the two tissues casually resemble one another, nevertheless they are fundamentally dissimilar.

Preliminary studies have been made of the mucous membrane of 38 human uteri removed at operation. The endometrial cycles were distributed as follows:

Early proliferative	6
Late proliferative	12
Early secretory	6
Late secretory	10
Post-menopausal	4

In each of these cases, similar blocks of the isthmic mucous membrane were prepared for comparison with the endometrial specimens.

Comparison of the endometrial functionalis with the isthmic mucosa confirms the observations noted above. However, when the endometrial basalis is examined in routine hematoxylin and eosin sections, it is found to be essentially similar to the isthmic mucosa. The basalis is of the same thickness. The general appearance of the glands, and their cyclic changes in response to the ovarian hormones, are the same. The characteristics of the stroma, and the vascular distribution, are similar. Special staining technics show further evidences of similarity. One concludes from these observations that the isthmic mucosa is in fact a continuation of the endometrial basalis and that it differs from the endometrium proper only in that the functional layer is lacking.

These observations cast serious doubt upon the propriety of designating the isthmus uteri as an entity of equal importance with the cervix and corpus. They suggest, rather, that this zone is part of the corpus uteri. Details of this study will be presented elsewhere.

Physical Studies on Corneal Tissues

H. J. Adler

Phillipsburg, New Jersey

S. T. Gross and J. M. Lambert[1]

General Aniline & Film Corp., Central Research Laboratory, Easton, Pennsylvania

Improvements in the technique of corneal grafting have increased the interest in the proper preservation of corneal donor tissue. Many investigations have dealt with corneal metabolism (*6, 11*), permeability (*4*), transparency (*1, 8*), hydration properties (*8, 10, 12*), X-ray diffraction (*9*), birefringence (*8*), and elasticity (*13*). A number of investigators (*2, 3, 5, 7, 14*) have reported on methods for preserving corneal tissue but of these only three (*3, 5, 7*) have applied biological methods for determining the viability of the aging cornea. No attempts were made in the past to correlate physical properties of the aging cornea with the transplantability of the tissue. For this brief review only the most pertinent references have been selected from a large bibliography.

The object of our brief investigation was to find some physical properties of corneal tissue which would measurably change during aging to indicate suitability for subsequent successful transplants. The experiments were made with bovine corneas and comprised 1) quantitative light transmission measurements as well as 2) X-ray diffraction studies. The eyes were removed immediately after death of the animal, rinsed with a 0.025% isotonic buffered thyrothricin solution, transported into a sterile moist chamber, and processed at the laboratory within 1 hr. During aging, the corneal tissues were kept in a refrigerator at a temperature of 5° C.

1) *Light transmission.* Experiments were made to determine the light transmission of corneal tissue with aging under different conditions. Periodic light transmssion measurements were performed on several corneas set up for simultaneous aging. A disk-shaped cellulose acetate sponge with a round opening in the center served as the

[1] The authors gratefully acknowledge the assistance of the General Aniline and Film Corporation in making available the facilities of its Central Research Laboratory.

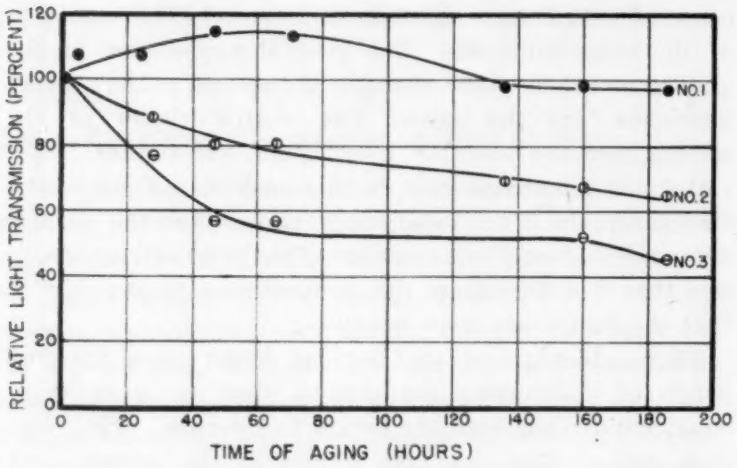


FIG. 1. Light transmission characteristics of aging corneal tissue. No. 1—in mineral oil; Nos. 2 and 3—in moist chamber.

support for the cornea. The auxiliary equipment consisted of a stabilized incandescent light source with a condensing system for producing a parallel beam of light which, after transversing an iris diaphragm and a blue filter, passed through the cornea. The transmitted light fell on the photocell equipped with a second iris diaphragm (set to a fixed 2-mm opening) and was measured by means of a photometer (Photovolt Model 500).

Typical results obtained with one set of bovine corneas are given in Fig. 1, showing relative light transmission values plotted against time of aging. Cornea No. 1 had been placed in mineral oil (Nujol) according to a procedure by Buerki (*2, 3*), which reportedly preserves corneal tissue for many days or even weeks; corneas Nos. 2 and 3 had been aged in a moist chamber. In the former case, Nujol was used to fill completely the chambers of the specimen holder, whereas in the latter case physiological saline solution was used merely to cover the bottom of the outer and inner chambers and to moisten the sponge supporting the specimen. The transmission values given in Fig. 1 were computed from the maximum photometer readings obtainable; relative values were obtained by assigning the value 100 to the amount of light transmitted initially by each cornea and expressing the other values in proportional units. With the first eight corneas studied, the photometric readings were not taken at maximum transmission and the results are therefore not strictly comparable.

The results obtained with two other sets of four bovine corneas, some aged in mineral oil and others in presence of saline solution as described above, were essentially like the ones presented, except for the apparent increase in light transmission shown in Fig. 1 (cornea No. 1). It is believed that a focusing effect caused by a slight mechanical deformation brought this about. In one case a cornea taken from an eye which had not been rinsed with thyrothricin solution gave the exceptionally low light transmission of 25% after about 100 hr in the moist chamber; subsequently the turbidity decreased, but this effect was probably due to bacterial attack or some other form of decomposition.

The light transmission data for corneas during aging appear to furnish a quantitative measure of their viability. Refinements of the technique might lead to the development of a method for testing corneal tissue and predicting its suitability for transplanting.

2) *X-ray diffraction.* Hertel (*9*) in 1933, using diffraction methods, carried through a very comprehensive investigation of the transparent tissues of the eye. His interest, however, was largely concerned with ultimate structure and constitution of materials available, and the effects on diffraction patterns of water content, ash constituents, etc.

In the present experiments, equipment was arranged so that corneal specimens could be maintained under conditions considered to be satisfactory for storage while the X-ray exposures were made. The camera, maintained near ice temperature, was filled with a fine mist of physiological salt solution to insure against moisture changes of any importance. Two samples each from four corneas were used.

Fresh corneas yielded diffraction patterns essentially identical to those published by Hertel for his fresh material. Corneal specimens were maintained at about 2°-5° C under an atmosphere of saturated relative humidity for various periods of time previous to examination. Aging under these conditions yielded diffraction patterns which were practically identical with those from samples which had not been aged, although there were indications of slight changes in the small angle scattering region. Samples preserved in mineral oil (*2, 3*) gave patterns equivalent to those indicated above, even when the sample was slightly hazy.

Air-dried samples and samples dried by immersion in successively more concentrated solutions of ethyl alcohol (from 30 to 100%) gave diffuse patterns quite similar to those of undried material, even though the sample turned opaque. Probably in this case the epithelium and endothelium were responsible for the appearance (*8*). Stretched samples both fresh and aged gave for the fiber period 11.2 A (Hertel finds 9.7 A) and the most intense spacing at right angles 2.85 A (Hertel finds 4.4 A). It must be concluded that the diffraction patterns furnish no evidence for degree of aging, and with the present technique cannot indicate whether an aged cornea is suitable for a successful transplant.

References

1. AURELL, G., and HOLMGREN, H. *Nord. Med.*, 1946, **30**, 1277.
2. BUERKI, E. *Schweiz. med. Wschr.*, 1947, **77**, 525.
3. BUERKI, E. *Ophthalmologica*, 1947, **114**, 288.
4. COGAN, D. G., *et al. Arch. Ophthal.*, 1944, **31**, 408.
5. FILATOV, V. P. *Optical transplantation of the cornea and tissue therapy.* Moscow, Russia: State Publishers of Medical Literature, 1945.
6. FISCHER, F. P. *Ergebn. Physiol.*, 1931, **31**, 507.
7. FRIEDENWALD, J. S., and BUSCHKE, W. *Trans. Amer. ophthal. Soc.*, 1944, **81**, 42.
8. HART, W. M. *Arch. Ophthal.*, 1947, **37**, 692; personal communication.
9. HERTEL, E. *Arch. Augenheilk*, 1933, **107**, 259.
10. KINSEY, V. E., and COGAN, D. G. *Arch. Ophthal.*, 1942, **28**, 272.
11. LEE, O. S., and HART, W. M. *Amer. J. Ophthal.*, 1944, **27**, 488.
12. LEYNS, W. F., *et. al. Acta Brevia Neerland. Physiol.*, 1940, **10**, 25.
13. SCHREUDER, M. *Ophthalmologica*, 1946, **99**, 490.
14. TAYLOR, A. C. *Anat. Rec.*, 1946, **96**, 579.

Comments and Communications

Use of Modified Ninhydrin Reagent in Quantitative Determination of Amino Acids by Paper Chromatography

Procedures for the quantitative estimation of amino acids separated on paper chromatograms have been reported.[1] In this laboratory we have been able to measure quantitatively some free amino acids in tissues of the rat by a method described elsewhere (AWAPARA, J. *J. biol. Chem.*, 1949, in press). Briefly, the procedure consisted in 1) locating the amino acid spots with a 0.05% ninhydrin solution in water-saturated butanol; 2) cutting the spots from the chromatogram and developing full color with 1 ml of 2% aqueous ninhydrin solution in presence of pyridine by heating on a boiling water bath for 20 min; and 3) transferring the colored solution to a volumetric flask and measuring the color intensity in the Beckman Spectrophotometer at 570 mμ.

TABLE 1

Density Values at Various Concentrations of Amino Nitrogen

Amino nitrogen	Optical density			
γ*	Glutamic acid	Aspartic acid	Glycine	Alanine
4	0.124	0.155	0.128	0.105
8	0.343	0.313	0.277	0.218
12	0.551	0.487	0.434	0.410
16	0.741	0.665	0.621	0.555

* Values given correspond to solutions made up to a volume of 25 ml, and corrected for paper blanks.

Recently S. Moore and W. H. Stein (*J. biol. Chem.*, 1948, 176, 367) have reported a modified ninhydrin reagent. They used a 2% ninhydrin solution in methyl cellosolve water at pH 5 (citrate buffer), which contained stannous chloride as a reducing agent. We have used this reagent instead of ninhydrin pyridine solution and obtained more consistent results and higher intensity of color. The intensity was found to increase considerably when larger amounts of reagent were used, up to 3 ml. Amounts greater than 3 ml were found to give constant values.

Table 1 shows density readings obtained at various concentrations for solutions of glutamic acid, aspartic acid, glycine, and alanine. In all cases the color intensity is a straight line function of the concentration. The greatest source of error in this procedure is the filter paper, which gives blank readings ranging from 0.070 to 0.100. This range of 0.030 units indicates an error of about 7% when 10 γ of amino nitrogen are being determined. The reproducibility of analyses carried out on the same sheet of paper is, however, very satisfactory with variations of about 1 to 2%. Best results were obtained when an aliquot of the colored solution was removed from the tube and made to a convenient volume. By this procedure, the difficult removal of all the color on filter paper remaining in the tube was avoided. The amount of color adsorbed on filter paper was constant.

ALTON J. LANDUA and JORGE AWAPARA

University of Texas,
M. D. Anderson Hospital for Cancer Research

[1] AWAPARA, J. *J. biol. Chem.*, 1949, in press; FISHER, R. B., PARSONS, D. G., and MORRISON, G. A. *Nature*, 1948, **161**, 764; NAFTALIN, A. *Nature*, 1948, **161**, 763; POLSON, A., MOSLEY, V. M., and WYCKOFF, R. W. G. *Science*, 1947, **105**, 603; and WOIWOD, A. J. *Nature*, 1948, **161**, 169.

More on High School Biology Requirements

Dr. J. van Overbeek's apprehensions as to the effects of the inadequate teaching of the biological sciences in the secondary schools of this country (*Science*, 1949, **109**, 210) are undoubtedly shared by a good many other biologists. I certainly agree that more adequate instruction in biology is needed in most of our secondary schools. However, Dr. van Overbeek's suggestion that we emulate the admirable Dutch program and require a course in biology in each year of high school is highly impractical. While he might have no difficulty convincing me and other biologists that this would be desirable, he would have little success in convincing most of those educators who are responsible for the secondary school curricula throughout the country. He would first have to convince them that *one* year of biology should be required of all high school students. At present many students are graduating from high school with nothing more in the way of science than a single (and usually inadequate) course in general science. It seems that the trend has been to reduce, rather than to increase, the science requirements for graduation from secondary schools.

Even if Dr. van Overbeek were successful in his efforts to have three or four years of biology required for graduation from high school, the program would fail through lack of qualified instructors. There are not even enough qualified biology teachers to handle the high school biology courses now offered. While there are many excellent teachers of high school biology scattered throughout the country, I believe it is safe to state that the majority, even in large cities, have so little training and interest in the subject that they almost waste their students' time. The prospects of an improvement in this situation are not encouraging. As all college and zoology professors know, their better and more capable majors go on to graduate school and eventually into research or college teaching.

Superior students are encouraged to do this, and perhaps rightly, but the result is that there are not very many really good high school biology teachers. This situation has apparently concerned most professional biologists very little, but I believe that there are now many who will agree with Dr. van Overbeek as to the importance of a biologically literate public and the role of the secondary schools in producing it.

Professional biologists, through their various societies, might well support a program designed to improve the quality and quantity of secondary school biology. While there may be little hope of attaining the goals set by Dr. van Overbeek, I think that substantial progress could be made toward securing the more general requirement of a year of biology for graduation from high school, and toward the improvement of these high school biology courses and the recruiting of more capable and interested teachers for them.

I believe that professional scientists might also take a greater interest in supporting and encouraging the extension of the excellent elementary school science programs which have been established in some cities. It is quite possible that good elementary school science instruction can have a more thorough and lasting influence than secondary school science instruction in developing a public with an interest in and appreciation of science and its methods, attitudes, and problems of general concern. Here again, one of the principal difficulties is adequately trained teachers.

VICTOR A. GREULACH
Department of Plant Physiology and Pathology
Agricultural and Mechanical College of Texas

Errata

My attention has been drawn by correspondents to two incorrect statements in my article "Research and Politics" (*Science*, March 4, 1949). First, it was stated that Vavilov died in a concentration camp. This should have read "died in exile in a remote region of the USSR," since the details are unknown. Second, I said that Kammerer committed suicide after going to Russia. Actually, he did so while still in Vienna, at the moment when he was finally to move to Moscow.

RICHARD B. GOLDSCHMIDT
University of California, Berkeley

I would like to call your attention to an error that crept into the paper on neomycin by Waksman and Lechevalier (*Science*, March 25). On page 307, right column, lines 1, 8, and 9, the letter μ should read m or *unit*.

SELMAN A. WAKSMAN
Department of Microbiology, Rutgers University

In the paper "The Effect of Choline-Deficiency on Uterine Activity of Rats," by Kraatz and Gruber (*Science*, March 25), the tenth line from the end, p. 312, ". . . choline every second" should be amended to read ". . . choline every second day."

CHARLES P. KRAATZ
Department of Pharmacology, Jefferson Medical College

(*Continued from page 375.*)

a plausible straight line is obtained which has an intercept on the $y + R$ axis of value R since $y = 0$ when $R = 0$.

The value so derived for R is 14 ± 2 mμ. Careful measurements over a wider range of ionization densities are in progress. The figure agrees well with the figure 18 mμ deduced by Luria and Exner (*3*) from observations of X-ray inactivation.

The results of deuteron bombardment of T-1 phage are thus consistent with the following hypotheses:

1. A target exists, of diameter 28 ± 4 mμ which is very much smaller than the phage itself and indeed smaller than the head of the phage.
2. The measured target size is larger than the true target, due to the fact that radiation from the path of a deuteron which misses the target can inactivate the phage.

References

1. DEMEREC, M., and FANO, U. *Genetics*, 1945, **30**, 119.
2. LEA, D. E. *Brit. J. Radiol.*, suppl. 1, 1947, p. 35.
3. LURIA, S. E., and EXNER, F. M. *Proc. Nat. Acad. Sci. Wash.*, 1941, **27**. 370.

NEWS and Notes

ACS at San Francisco. More than 3,500 chemists and chemical engineers participated in the **115th national meeting of the American Chemical Society** held in San Francisco March 28–April 1. Advances in fields ranging from the biochemical approach to genetics to the application of chemical engineering techniques in the control of air pollution were reported in 670 papers at sessions of 17 professional divisions of the Society.

The need for more teamwork among scientists of all disciplines in dealing with the increasingly complex problems encountered on the research frontiers today was emphasized by Arne Tiselius of Sweden, 1948 Nobel Prize winner in chemistry, at a general assembly of the Society. Professor Tiselius described "Some Trends of Development in Present Day Biochemistry."

Selection of Arthur B. Lamb, of Harvard University, for the past 30 years editor of the *Journal of the American chemical Society*, to receive this year's Priestley Medal was announced at the general session. Professor Lamb, who was cited for outstanding services to chemistry, will retire from his editorial post at the end of this year.

Names of the winners of eight other awards administered by the Society also were announced by Linus Pauling of the California Institute of Technology, president of the Society. They are: Garvan Medal—Agnes Fay Morgan, chairman of the Department of Home Economics, University of California, Berkeley; American Chemical Society Award in Pure Chemistry (financed by Alpha Chi Sigma)—Richard T. Arnold, University of Minnesota; Borden Award in the Chemistry of Milk—George R. Greenbank, U. S. Department of Agriculture, Bureau of Dairy Industry; Eli Lilly and Company Award in Biological Chemistry—Irving M. Klotz, Northwestern University; Paul-Lewis Laboratories Award in Enzyme Chemistry—Henry A. Lardy, University of Minnesota; Fisher Award in Analytical Chemistry—G. E. F. Lundell, retired chief of the Chemistry Division, National Bureau of Standards; Fritzsche Award in Essential Oils—John L. Simonsen, Imperial Institute, South Kensington, London, England; and Precision Scientific Company Award in Petroleum Chemistry—B. H. Sage, California Institute of Technology. All the awards will be presented at the Society's fall meeting in Atlantic City, New Jersey.

Two symposia sponsored by the Division of Biological Chemistry were among the outstanding sessions on the San Francisco program. At a meeting on viruses, Albert P. Krueger and associates, of the University of California, reported that bacteriophage, the mysterious germ-killer produced by bacteria themselves, has for the first time been made artificially in the absence of living cells. At the symposium on the relation of genetics to biochemistry, Daniel Mazia, University of Missouri, reported evidence indicating that the innumerable variations of physique and character distinguishing each man from all others may result from immeasurably small differences in a single body chemical—desoxyribonucleic acid, a component of genes and chromosomes.

The first practical synthesis of an antibiotic drug was reported at the meeting. Chemists of Parke, Davis and Company told the Medicinal Division of finding methods of making artificial chloromycetin. Discovery of an unidentified substance which may be responsible for high blood pressure in human beings was announced by Henry A. Schroeder of the Washington University School of Medicine.

Development of air pollution standards for Los Angeles, which may prove applicable to industrial cities everywhere, was announced by Louis A. McCabe, head of the Los Angeles Air Pollution Control District. Several new insecticides were described, among them a material known only as Compound 497—said to be many times as effective as DDT against roaches and houseflies. At the same session, devoted to "Economic Poisons," warnings were sounded against the potential health hazards presented by the powerful new pest-killers.

The purity of water used for irrigation purposes, new findings concerning the path of carbon in photosynthesis, and the application of microanalytical methods to petroleum chemistry were among the other subjects discussed at the meeting.

WALTER MURPHY

W. C. Davison, dean of the Duke University School of Medicine, has been appointed a consultant to the U. S. Army Surgeon General, and will serve his first month's duty in Tokyo. Returning from Japan, he will stop in Shanghai for a week to conduct clinics in pediatrics for the American Bureau for Medical Aid to China.

Francis W. Reichelderfer, chief of the U. S. Weather Bureau, has been named vice president of the American Geophysical Union of the National Research Council, to fill the unexpired term of Harald U. Sverdrup, who has returned to Norway. The term expires June 30, 1950.

Floyd Firestone, consulting physicist and editor of the *Journal of the acoustical Society*, has been named program director of underwater acoustics research for the Office of Naval Research.

Roland McKee, Division of Forage Crops and Diseases, U. S. Department of Agriculture, has retired after more than 43 years with the Department.

James C. Spence, professor of Child Health, University of Durham, England, will deliver the Cutter Lecture on Preventive Medicine at the Harvard Medical School May 11. His topic will be "The Role of Parents in Child Health."

J. Gilman Reid has been appointed chief of the Engineering Electronics Laboratory of the National Bureau of Standards, where he has been a staff member since 1937. He will direct research on electronic instrumentation, miniaturization, printed circuit processes and

techniques, electronic circuit components, and electronic standards. Other recent appointments are **C. H. Townes,** and **P. Kusch,** both professors of physics at Columbia University, who will be consultants to the Microwave Standards Laboratory.

Ralph E. Fadum, professor of soil mechanics at Purdue University, has been named head of the Department of Civil Engineering, at North Carolina State College of Agriculture and Engineering. He will succeed C. L. Mann, who retired last fall after more than 50 years on the faculty. Dr. Fadum will take over his new duties July 1.

W. H. Twenhofel, editor of the *Journal of Sedimentary Petrology,* has been elected honorary member of the Society of Economic Paleontologists and Mineralogists.

A. L. Patterson, assistant professor of physics at Byrn Mawr, has been appointed senior member in charge of the Physics Department of the Institute for Cancer Research, Philadelphia, effective September 1.

Paul F. Sharp, former director of research, Golden State Company of California, has been appointed director of the California Agricultural Experiment Station at Berkeley. He will succeed **C. B. Hutchison** who continues as professor of agriculture, dean of the College of Agriculture, and vice president of the University of California.

Morris Schaeffer, assistant professor of pediatrics at Western Reserve University School of Medicine, and director of the Cleveland City Hospital Contagious Department, has been appointed director of the Virus and Rickettsial Research and Epidemiology Branch of the Communicable Disease Center, U. S. Public Health Service, effective June 30.

Frank A. Hartman, research professor of physiology, Ohio State University, has returned after spending three months at the Barro Colorado Island Laboratory in the Panama Canal Zone, and in western Panama, collecting and studying adrenals of birds and other vertebrates.

A. C. Smith, Smithsonian Institution botanist, has been appointed a vice president of the taxonomy section of the Seventh International Botanical Congress, to be held in Stockholm next year, and Roy E. Clausen, Berkeley geneticist, will be a vice president of the section on genetics.

B. N. Uppal, former principal of the College of Agriculture, Poona, India, has been appointed director of agriculture for Bombay Province.

Visitors to U. S.

John R. E. Bradfield, Fellow of Trinity College, Cambridge University, England, recently spent two weeks studying autoradiographic techniques with George A. Boyd in the Atomic Energy Project Laboratories at the University of Rochester School of Medicine.

Raj Chandra Bose, former head of the graduate department of statistics, University of Calcutta, India, has arrived in this country to accept appointment as professor of mathematical statistics at the University of North Carolina.

Necmettin Polvin, professor of neurology at the University of Istanbul, is spending several months in the Tissue Culture Laboratory of the University of Texas Medical Branch, Galveston, in association with C. M. Pomerat, director. They are developing new methods for the growth of brain tissue in artificial media.

Grants and Awards

The University of North Carolina has received a $4,500 **Frederick Gardner Cottrell** grant from the Research Corporation of New York City for fundamental research in the structure of polymers derived from pyrones. The project will be under the direction of Richard H. Wiley, professor of chemistry.

Winners of the **Frank B. Jewett Fellowships for 1949–1950** named by the American Telephone and Telegraph Company are: Harish-Chandra, mathematician, Institute for Advanced Study; James A. Jenkins, mathematician, Harvard University; Robert Karplus, physicist, Institute for Advanced Study; Joaquin Mazdak Luttinger, physicist, Physikalisches Institut, Zurich, Switzerland; David Emerson Mann, chemist, University of Minnesota; and Harvey Winston, chemist, Columbia University. The awards grant $3,000 to the recipient and $1,500 to the institution at which he chooses to do his research. Drs. Luttinger, Karplus, and Jenkins were among the award winners last year.

The Rockefeller Foundation has recently granted $29,000 to the University of California for research on the comparative biochemistry of marine organisms, particularly animal biochromes, to be conducted under the direction of Denis L. Fox, professor of marine biochemistry, at the Scripps Institution of Oceanography. The money is to be used during a four-year period, beginning July 1, 1949, and is a renewal of a similar grant for the biennial period 1947–49.

Lawrence Tyler Post, head of the Washington University Medical School Department of Ophthalmology, has been awarded the **Leslie Dana Medal** by the St. Louis Society for the Blind, in recognition of his work with blindness.

Fellowships

Cornell University has established 16 undergraduate scholarships for students from abroad. Five will be awarded in agriculture, four each in veterinary medicine and industrial and labor relations, and three in home economics.

The New York State mental health authority has allocated funds for 10 $1,600 fellowships in social work. They will be granted, upon recommendation of the advisory mental health council, to students who have completed their first year in graduate school and who wish to specialize for their second year in psychiatric social work, in preparation for community mental hygiene or child guidance clinic work. Inquiries may be addressed to Miss Hester B. Crutcher, director of psychiatric social work, New York State Depart-

ment of Mental Hygiene, Governor Alfred E. Smith State Office Building, Albany, New York.

Colleges and Universities

The University of Utrecht, Holland, is planning a series of scientific films, intended to cover the entire field of science. The first films will be on medicine. The Ministry of Education and the various faculties will contribute to production costs, and a grant has been made for the purpose by the Rockefeller Foundation.

The College of Medicine, University of Vermont, and the Vermont Association for the Crippled are jointly sponsoring a course in the diagnosis and treatment of convulsive disorders. Lectures, designed to meet the needs of the general practitioner, will be held in Burlington, Vermont, April 18–23. W. G. Lennox, of the Neurological Institute of the Children's Medical Center, Boston, will give two lectures on epilepsy.

Summer Programs

The Biological Laboratory, Cold Spring Harbor, Long Island, New York, is offering, for the fifth successive year, a summer course on bacteriophages, June 27–July 16. The course will be given by Mark H. Adams, New York University, and is designed to acquaint research workers with techniques used in work with bacterial viruses, and with recent results of such work. Further information may be had by writing the Laboratory.

Smith College School for Social Work announces its summer program of graduate seminars for experienced social workers, to be held July 11–21. Students are required to elect at least two, but may enroll for three of the following courses: advanced casework, supervisory methods in social casework, ego psychology, the psychosomatic concept, educational methods in teaching casework, and casework writing and interpretation. Each seminar is limited to 30 students, and applications should be made by *May 15*. For additional information write: Florence R. Day, director, Smith College School for Social Work, College Hall 8, Northampton, Massachusetts.

The University of Chicago will hold a workshop for research workers and teachers interested in problems of adjustment to old age, August 8–27, under the direction of Ernest W. Burgess, chairman of the Department of Sociology, and Robert J. Havighurst, of the Committee on Human Development. The University will also be host to an Institute on the Study of Old Age, August 8–12.

Meetings and Elections

Six Messenger Lectures on acoustics are being given at Cornell University, April 11–21, by Harvey Fletcher, director of physical research of the Bell Telephone Laboratories.

The Fourteenth Cold Spring Symposium on Quantitative Biology will be held June 8–16. The topic is "Amino Acids and Proteins," with emphasis on the biological aspects of the problem. Program participants will include: K. Linderstrom-Lang, from Denmark; C. Fromageot and J. Roche, from France; D. Crowfoot, J. F. Danielli, F. Sanger, and R. L. M. Synge, from Great Britain; and K. O. Pedersen, from Sweden. Attendance is restricted by space limitations to about 100. For program and information, write to the Biological Laboratory, Cold Spring Harbor, New York.

The Naval Ordnance Laboratory aeroballistics facilities at White Oak, Maryland—supersonic and hypersonic wind tunnels, and transonic and pressurized ballistics ranges—will be formally dedicated June 27. There will be five half-day technical sessions June 27–29 on general aerodynamics, ordnance aeroballistics (restricted), theoretical supersonic and transonic aerodynamics, and experimental supersonic aerodynamics at which foreign and U. S. scientists have been invited to present papers. The Fluid Dynamics Division of the American Physical Society will meet June 30 and July 1 at the Naval Ordnance Laboratory and will sponsor symposia on turbulence, shock-wave phenomena, and aerothermodynamics. Those interested in attending the dedication and technical sessions June 27–29 should write to R. J. Seeger, U. S. Naval Ordnance Laboratory, White Oak, Silver Spring 19, Maryland.

The Virginia Academy of Science will hold its 27th annual meeting at the Hotel John Marshall in Richmond, May 5–7. Final winners in the Virginia Science Talent Search will be selected, together with all winners in the Science Clubs Contests. Their names will be announced at the dinner of the Junior Academy of Science on Thursday evening by James W. Cole, Jr., of the University of Virginia, and Boyd Harshbarger, of the Virginia Polytechnic Institute, president-elect of the Academy. The dinner speaker will be Major T. F. Walkowicz, of the United States Air Force. Following his address, a sound motion picture entitled "Atomic Physics" will be shown under the auspices of the Atomic Energy Commission and the Oak Ridge Institute of Nuclear Studies.

The annual business meeting of the Junior Academy will be held at 2:00 P.M. on May 5. C. M. Kincaid, of the Virginia Polytechnic Institute, will speak on "Genetics, an Expanding Science," and Gordon Silas, of Roanoke College, will present a paper on "The Anatomy of Human Behavior."

The first meeting of the senior division of the Academy will be held Thursday evening at 8:30 o'clock. At this general conference, reports of 16 committees will be made. These reports will be published later in the 1948–1949 *Proceedings* of the organization.

Section meetings of the Academy will begin at 9:00 A.M. on Friday, May 6. Approximately 250 papers will be presented in the branches of science represented by the following Sections: agricultural sciences, astronomy, mathematics and physics, bacteriology, biology, engineer-

ing, education, chemistry, geology, medical sciences, psychology, statistics, and science teaching methods. Virginia winners of honorable mentions in the National Science Talent Search and winners in the state search will present their essays in appropriate Sections. An attendance of approximately 800 is expected for these sessions. The Section on engineering, which has not met since before the war, will be reactivated at this meeting. The program of a new Section for science teachers will be presented on May 6 and 7. Collegiate members of the Academy will hold a special session at 3 o'clock on Friday afternoon.

During the three days of the meeting about 30 educational and commercial exhibits will be shown in the lobby and Virginia Room of the Hotel John Marshall. The U. S. Air Force will offer the second showing of its communications exhibit, which will come directly from the Grand Central Palace in New York City. The Oak Ridge Institute for Nuclear Studies will have an exhibit on radioactive substances. A number of exhibits also will be shown by individual high school students and by science clubs. Sound motion pictures having to do with the history of Virginia and various scientific subjects will be presented at several of the exhibit booths.

Tours of industrial plants and points of historical interest will be conducted on Friday afternoon. At 4:00 o'clock, the annual tea of the Academy will be held at the Valentine Museum. The Governor of Virginia will be present to welcome the scientists of the state. The Academy dinner will be served at 7:00 P.M. in the roof garden of the John Marshall. The highlights of this dinner meeting will be the presentation of the J. Shelton Horsley Research Award to a Virginia scientist for a highly meritorious paper reporting original scientific research, and an address by Howard A. Meyerhoff, administrative secretary of the American Association for the Advancement of Science. Officers of the Academy for 1949–1950 will be installed by Sidney S. Negus, Academy president.

Meetings of Sections will continue until noon on Saturday. Field trips will be conducted by geologists and botanists in the afternoon. On Saturday evening, all in attendance at the meeting are invited by those in charge of the Virginia Industrial Exposition to be guests at a preview at the Atlantic Rural Exposition grounds, arranged for members of the Academy.

The National Registry of Rare Chemicals, 35 West 33rd Street, Chicago 16, Illinois, has submitted the following list of wanted chemicals: cumic acid, 5-pentadecylresorcinol, perylene, propadiene, 1,3,5-hexatriene, myosmine, thymotic acid, thujyl alcohol, 1,2-hexadiene, 3-semicarbazidobenzamide, 2,5-thiophanedicarboxylic acid, sodium chlorosmate, sinigrin, hemopyrrole, fumigatin, 2,3-dihydroxynaphthalene, cis-9-dodecenoic acid, 2,4,5-trinitrotoluene, pyrographitic acid, and phthionic acid.

The Scientific Monthly, in cooperation with the Smithsonian Institution, will sponsor for the third year the **International Photography-in-Science Salon,** a competition to encourage and extend the use of photography as a basic research tool. Entries will be received by the editor of *The Scientific Monthly,* 1515 Massachusetts Ave., N.W., Washington 5, D. C., from August 24 to September 14, 1949.

First, second, and third awards and five honorable mentions will be given for the scientific photographs judged to be the best in the black-and-white and color sections of the Salon. Specialists in science and photography who will serve as the judging committee will consider the initiative, originality, and results obtained more than the composition and pictorial quality. All photographs must be taken for scientific purposes.

The prints selected for awards and display will be shown at the U. S. National Museum during October 1949 and at the New York meeting of the AAAS in December. They will then go on tour of scientific centers here and abroad.

Earlier prize winners have been William F. Meggers, chief of the Spectroscopy Section, National Bureau of Standards, for "Natural and Artificial Mercury, 5461 A"; Thomas C. Poulter and Walter K. Lawton, of the Southwest Research Institute, for "Photographic Study of the Explosive Charge used in the Poulter Method of Seismic Exploration"; and Edwin R. Willis, of the Philadelphia Quartermaster Depot, for a photograph taken in an investigation of the olfactory responses of female mosquitos.

The origin of corn, which has puzzled botanists for four centuries, is a step nearer solution because of a discovery in central New Mexico of cobs and pieces of corn more than 4,000 years old. The discovery was made last summer by Herbert Dick and C. Earle Smith, on a Peabody Museum expedition searching for traces of early American man in the Upper Gila River area. Over 700 cobs were found in a layer of accumulated refuse in Bat Cave, in New Mexico. By carefully removing the debris, which consisted of ashes, animal bones, and other refuse in six strata, each about a foot thick, it was possible to study the specimens. Writing in *The Journal of Heredity,* Paul C. Mangelsdorf, director of the Botanical Museum at Harvard, and Mr. Smith report that "the primitive corn found by the expedition, although probably not itself wild corn, is [possibly] not far removed in its characteristics from the long sought for wild corn." The discovery also shows that primitive corn was both a pop and a pod corn, and was not, as many botanists have supposed, derived from teosinte, a Central and South American grass closely related to corn.